EMPIRE COTTON GROWING CORPORATION

PROGRESS REPORTS FROM EXPERIMENT STATIONS

SEASON 1950 - 1951

Price 3s. 0d., post free

LONDON
1952

PROGRESS REPORTS FROM EXPERIMENT STATIONS, SEASON 1950-1951.

Price 3s. 0d., post free.

Published by the Empire Cotton Growing Corporation,
12, Chantrey House, Eccleston Street, S.W.1.
1952

A

CONTENTS.

	Page
FOREWORD	1
COTTON RESEARCH STATION, NAMULONGE	4
UGANDA :	
Control of Blackarm Disease in Cotton	27
Cotton Variety Testing and Seed Distribution	35
TANGANYIKA TERRITORY :	
Lake Province	45
KENYA, Nyanza Province :	
Summary of Reports on Cotton, 1946–50	60
Cotton Experiments, 1950–51	64
ANGLO-EGYPTIAN SUDAN :	
Introductory Note	68
Gezira Station	69
Shambat Station	75
Kadugli Station	83
NYASALAND :	
Cotton Experiment Station	92
SOUTHERN RHODESIA :	
Gatooma Station	98
NORTHERN NIGERIA :	
Cotton Breeding	105
Entomology	116
WEST INDIES :	
Introductory Note	131
Antigua Station	133
Montserrat Station	144
St. Vincent Station	147
QUEENSLAND :	
Biloela Station	150

FOREWORD

BY

J. B. HUTCHINSON.

The outstanding feature of the year was the record yield in the Sudan Gezira, where an average of 2,079 lb. of seed cotton per acre was reaped from an area of 207,000 acres. Northern Nigeria also made a record. In a season that was not especially favourable, increased interest in cotton led to the realization of an export crop of 75,000 bales. A satisfactory, though unspectacular achievement, was the production of 40,000 bales in the Lake Province of Tanganyika, in spite of the easy money obtainable from hedgerow sisal.

Indications of the extension of the Corporation's responsibilities are given by the account of the official opening of the Cotton Research Station, Namulonge, the appearance of a report from the officer posted to the Nyanza Province of Kenya, and the record of a visit by the Senior Entomologist to advise on pest problems in the new irrigated crop in the Aden Protectorates.

Crop Husbandry.

Emphasis on the rewards obtainable from better use of the land is to be found throughout the reports. Evidence of the value of good tillage practices is given in the Tanganyika and West Indies reports, and data on the dependence of yield on timely planting in reports from Uganda, Tanganyika, Kenya and Nigeria.

One of the most interesting features of the manurial trials is the existence of the long term residual effects demonstrated at Ukiriguru. These residuals seem to depend primarily on phosphate, and the frequency with which phosphate responses are to be found in cotton trials is likely to be of importance to the fertiliser industry. Nitrogen responses are widespread and often large, but the economics of nitrogen manuring is closely bound up with the nature of the nitrogen cycle in the soil. Free distribution of phosphate has been arranged in Northern Nigeria and in the Lake Province of Tanganyika, and in the Lake Province free distribution of nitrogenous fertilisers is contemplated.

Climatological work at Namulonge is directed towards the elucidation of the basic factors of the crop/climate relationship. In particular, water relations are under study, and the relation between rainfall and soil moisture. It is shown that one of the most important factors governing water relations is the structure of the surface layers of the soil, through which rainfall must percolate if soil moisture is to be augmented.

Mechanisation problems are everywhere important and progress in their solution is recorded. Mechanical picking is under trial in Queensland and Southern Rhodesia.

Entomology.

Considerably more work is reported this year on insecticidal control. The greatest success seems to have been in the control of American bollworm. In Northern Nigeria some control of red bollworm was achieved, but in Southern Rhodesia the insecticides used do not appear to have had any effect on it. In Antigua a pest complex including leafworm, American bollworm and *Nezara* was kept in check. The most useful insecticides have been DDT and toxaphene.

Plant Pathology.

There is increasing recognition of the importance of bacterial blight, or blackarm disease. Though the ultimate solution of the disease problem is generally recognised to be the breeding of varieties with an adequate level of resistance, seed disinfection has been undertaken with success as an immediate measure of control in eastern Uganda. The complexity of the relations between the pathogen, the host, and the environment makes both resistance breeding and sanitary control extremely difficult, and the pathological studies in progress at Namulonge are therefore of great importance for both lines of attack on the disease.

Verticillium wilt is also under study at Namulonge, and the first stage, that of devising a precise measure of host resistance, is well advanced. Studies of the biology of the pathogen in the soil, though equally important, take longer to develop.

Plant Breeding.

Important progress is recorded in the distribution of new pedigree varieties. In Uganda S47 has been distributed in Teso, and plans are recorded for extending it over the whole of the Eastern and Northern Provinces of the Protectorate except Busoga. Evidence is presented for the conclusion that the new variety played an important part in the achievement of a record crop in Teso.

Uk46 now covers most of the Lake Province, Tanganyika, and has led to striking improvements in jassid resistance and ginning out-turn. The improvement in the market reputation of AR Mwanza is also worthy of note. Though yield advances over the area as a whole are difficult to assess, there is little doubt that the better variety contributed to the achievement of a 40,000 bale crop in spite of the diversion of the cultivator's interest by the high price obtainable for hedgerow sisal. Uk48 has shown great promise in the Nyanza Province of Kenya as well as in its own territory, and is now being multiplied in both areas. The release of a third improvement, Uk51, is announced.

In Nigeria, thanks to close supervision, early planting, and superphosphate manuring, the rate of multiplication of Samaru 26C has handsomely exceeded expectation, and a greater rate of replacement of the old stock is now possible. In the Sudan, the new blackarm resistant strains of both Egyptian and Upland cottons are being grown on an increasing scale.

Stocks in course of development include those with high resistance to bacterial blight in the Sudan and at Namulonge, high jassid resistance in the Sudan, at Namulonge, and in Queensland, and high quality Sea Island in Antigua.

An important feature of the plant breeding reports is the information given on breeding techniques. The Sudan report includes valuable tables summarizing the performance of synthetic blackarm resistant strains against their susceptible parents in both yield and spinning behaviour. The agreement in spinning values provides a striking demonstration of the efficiency of the backcrossing technique. In yield, the new strains are equal to, or slightly below the susceptible parents in trials in which blackarm was not important. Where the disease was present, the advantage of resistance is manifest. It seems fair to conclude that though breeding to a model in this way is perfectly feasible, until the target is actually achieved the new strain is more likely to fall short than to exceed the pattern in yield. One may be permitted to express the hope that the problems involved in the precise achievement of the aim will be further discussed by Knight in a technical paper. Here it will be sufficient to note the method used to trim up a new synthetic variety in any respects in which it falls somewhat short of the model.

In the Sudan this final trimming up is known as " filtering." The " modal bulk " technique in use at Namulonge is similar, and is used for the same purpose. A rather more elaborate version, also for the same purpose, is the " screening " described in the Northern Nigerian report. Essentially these are all methods of exploiting the residual variability in pedigree material to establish certain desired modal values. Mass selection methods have been found adequate for the purpose at Namulonge, but for the particular needs of the Sudan and of the Northern Nigerian work use is made of progeny rows.

An important statistical analysis of yield advance in the BP52 breeding work is given in the Namulonge report. Development of this approach may be expected to lead to a closer control of breeding work, and a realistic assessment of the potentialities of breeding stocks.

Conclusion.

The reports record a year of notable progress in production, and of wide ranging investigations in which the study of immediate needs is nicely balanced with long range research.

Received April 1952.

COTTON RESEARCH STATION, NAMULONGE.

PROGRESS REPORT FOR THE SEASON 1950-1951

CROP CALENDAR

	Cotton	*Food Crops*
Sowing	... Mid-June—end August	... January—April.
Flowering	... September—November	... —
Reaping	... December—March...	... May—August.

INTRODUCTION

BY

J. B. HUTCHINSON.

The Parnell Laboratories were officially opened on November 9th, 1950, by H.E. Sir John Hathorn Hall, G.C.M.G., D.S.O., O.B.E., M.C., Governor of Uganda, in the presence of a large company of Government officials, distinguished scientists and members of the public. On the following day the first meeting of the Namulonge Advisory Board was held, and the station was open to visitors with scientific and agricultural interests.

At the end of May 1951 the major building programme was almost complete. Of the staff houses, 11 and the Guest House were in occupation, one was practically ready for occupation, and the remaining one was nearing completion. Outside laboratories, glasshouse, and food stores were complete, and the ginnery building was in course of erection.

Eleven staff members, and an Insecticides Officer on the staff of E.A.A.F.R.O. were in residence, and a full experimental programme was carried out during the season.

Relations with the Department of Agriculture have been close and friendly and have contributed greatly to the effectiveness of the work of the station.

During the year advisory visits were paid by members of the staff to the following territories :

ADEN. By Mr. Pearson to advise on insect pests in new Egyptian cotton growing projects. It may be noted that American bollworm appeared to be important, and both pink and red bollworm were discovered in an area of ancient cultivation. The latter is of special interest, as the only record of *Diparopsis* outside Africa.

BARBERTON. By Dr. Wickens to follow up earlier work on the carryover and spread of *Verticillium* wilt.

KENYA. By Dr. Hutchinson to discuss with the Dept. of Agriculture experimental work and an improvement programme for the Nyanza Province cotton crop.

NYASALAND. By Mr. Pearson for discussions on entomological problems in the Lower River area.

SIERRA LEONE. By Mr. Prentice to advise the local Government on the prospects of developing a commercial crop.

Close contact is maintained with members of the staff of Makerere College working in the Currie Laboratory, some of whom are engaged in research projects of direct relevance to our own problems.

THE FARM

BY

A. L. STEPHENS.

Cotton.—49 acres of cotton were grown in the 1950-51 season, of which 25 acres were under breeding plots, trials and bulk increase of BP52 strains. Planting of BP52 was spread over ten weeks from mid-June to the end of August, and though not strictly comparable, the yields are of interest.

Date.	*Mean Yield. (lb. seed cotton per acre)*	*Acreage.*
Mid-June	961	3
July 12th	582	3·75
July 21st	575	5·35
August 5th—11th	448	3·42
August 22nd—28th	379	3·93

Mechanical Cultivation.—Owing to an acute shortage of manual labour it has been essential to mechanise farming practice as completely as possible. In land clearing all sizeable trees are uprooted by a monkey winch ; thick scrub in the old peasant housing areas is rooted out using a ripper ; elephant grass is broken down by a disc harrow ; and termite hills and uprooted trees are removed by a bulldozer.

For the first ploughing after clearing it has been found that the heavy, high clearance, 3 furrow mouldboard plough with bar points has been more successful than the heaviest disc plough which our 40 h.p. crawler tractors are capable of hauling, for whereas the latter plough " crabs " when it comes up against large elephant grass clumps and the stumps of shrubs, and rides over tree roots, the former is successful in turning over the clumps and stumps and either rips up the roots or advertises their presence.

To facilitate the use of the Tanganyika " tie-ridging " system, a ridge-tier attachment was designed for the Fordson toolbar mounted ridger. Ridge cultivation has presented the problem of planting successfully on ridges ; independent seeders mounted on the Fordson

toolbar, using a ridging body in one of the furrows to steady the planters on top of the ridges, have been used with success where the tilth was fine enough, but the driving wheels of the seeders are too small for the usual seed bed here. Normal row crop weeding with steerage hoes fitted with normal hoe blades has not been very satisfactory owing to the very vigorous weed growth, and more success in weeding and less damage to the crop has been obtained by using the ordinary ridging bodies with their attendant ridge-tiers. The uprooting of the cotton plant at the end of the season, which is usually done by hand, has been accelerated by the use of beet lifting attachments on a Ransome's toolbar. The grass paths between cultivated strips have been successfully planted with *Paspalum* slips using a Robot planter.

Operational records, standardised with those of the Agricultural Department, are being kept and data so obtained are supplied to the Special Development section of that Department.

Climatology

BY

H. L. MANNING AND H. G. FARBROTHER.

Data accumulated during the season support the belief that the distinguishing features of the cropping cycle of cotton in Uganda are primarily climatological in origin, and this relationship between climate and crop physiology appears so important as to justify an extended programme of study.

Prominent amongst the many problems confronting a new station is that of optimum sowing dates for the various crops. Cotton was naturally considered first, and inferences drawn from field trials conducted by the Agricultural Department indicated that mid-June should be satisfactory. The 1950-51 cotton season began in June with relatively high rainfall. Later sowings, particularly towards the end of July, experienced less favourable moisture conditions. Indeed, if an estimate of soil moisture losses may be derived from one third of the losses from an open water surface (Trumble, 1937), the rainfall for July was sufficient only to balance the probable losses from bare soil (see Table 1). Mean daily hours of sunshine, estimated from a Campbell-Stokes recorder, were 4·1 for July and 4·2 for August. Slow early development of cotton was undoubtedly related to this comparatively low radiation intensity.* During the latter part of the season unusually high rainfall around the time of flowering contributed to crop losses, particularly of the early June sown cotton. Annual rainfall data from Kawanda and Bukalasa indicate that the 1950 total for Namulonge of just under 60 inches is not likely to occur more frequently than once in ten years. There is no reason, therefore, to

* Data from the Government agricultural station at Kawanda indicated that these means are quite typical. Their magnitude is the more striking by comparison with Kew, where values of between 7 and 8 hours per day are expected for the same months, though of course under quite different circumstances. Mean values for the two months after cotton planting at Barberton are respectively 6·0 and 5·9.

contemplate a change of sowing period from the mid-June optimum. Some of the climatological data are summarised in Table 1.

TABLE 1.
SUMMARY OF METEOROLOGICAL DATA AT NAMULONGE. JAN.—DEC., 1950.

Month.	*Rainfall inches (Number of rainy days in brackets).*	*Mean hours of sunshine per day.*	*Mean max. °F.*	*Mean min. °F.*	*Relative Humidity at hrs. E.A. time* 09·00	14·30	*Total Evaporation (Inches per month from open surface 22 in. diameter.)*	
January ...	3·42 (9)	7·1	86·1	61·1	83·3	46·1	—	
February ...	4·56 (8)	7·0	85·7	61·5	79·2	49·9	—	
March ...	7·00 (14)	6·1	84·8	62·5	76·0	52·9	—	Food Crops
April ...	9·02 (19)	5·2	81·9	63·0	86·3	62·1	—	
May ...	7·44 (18)	5·3	82·7	63·7	84·9	64·8	—	
June ...	4·98 (10)	6·2	80·5	60·9	84·8	62·7	2·85	Cotton Sowing
July ...	1·27 (9)	4·1	79·5	59·6	87·9	59·3	3·13	Cotton
August ...	3·51 (15)	4·2	81·3	60·6	82·6	58·0	2·68	
September	5·86 (15)	5·2	81·6	60·1	80·0	63·5	2·57	
October ...	6·14 (18)	5·1	82·5	61·1	79·6	60·7	2·82	
November	2·82 (8)	6·4	85·0	60·5	72·3	51·0	3·96	
December	3·96 (10)	6·2	83·7	60·4	80·7	52·5	3·88	
Total ...	59·98	—	—	—	—	—	—	
Means ...	—	5·7	82·9	61·3	81·5	57·0	—	

Since soil moisture is fundamental to plant development and in addition has been shown to be associated with accumulation of nitrate nitrogen, the relationship between soil moisture and preceding rainfall is a problem of great importance, and investigations have been initiated on the incidence of rainfall and its subsequent fate. For this purpose, standard pattern meteorological instruments are unsatisfactory, and new types of evaporimeters, run-off gauges, drain gauges and rainfall rate recorders (Farbrother, 1951) were devised and installed during the year. Though collected over a limited period, the data obtained are nevertheless extremely interesting. For example, among storms experienced between June 1950 and March 1951, peak intensities of as much as 10 inches of rain per hour were recorded. In fact peak rates in excess of 5·5 inches per hour are not uncommon. A summary of storms with peak rates equal to or greater than 0·5 inches per hour is given in Table 2.

TABLE 2.
PEAK RATES IN INCHES PER HOUR OF STORMS EXCEEDING 0·5 INCHES PER HOUR AT NAMULONGE. FROM JUNE, 1950—MARCH, 1951.

Range (ins.)	*Frequency.*	*Percentage.*	
0·5 — 1·49	15	23·4	
1·5 — 2·49	15	23·4	
2·5 — 3·49	18	28·2	
3·5 — 4·49	7	10·9	
4·5 — 5·49	3	4·7	
5·5 — 6·49	2		9·4
6·5 — 7·49	2		
7·5 — 8·49	1		
8·5 — 9·49	—		
9·5 —10·49	1		
	64		

It will be seen that 25 per cent of the storms of more than $\frac{1}{2}$" per hour recorded during this period had a peak rate in excess of 3·5 inches per hour.

Data from a shallow (10" deep) drain gauge showed that one of the effects of the heavy rain on bare soil was to impede percolation, even though the soil was recently opened from natural vegetation, and had a good structure. This effect was so marked that within three months of the installation of the equipment, drainage at the 10 inch level had ceased. This of course has an important bearing on the relationship between soil moisture and previous rainfall. Light rains tend to have low intensities and a correspondingly greater opportunity for percolation; big storms more often have high peak rates which, by their impacting effects, impede percolation and result in greater run-off. In this connection it is of interest to note that in a matter of weeks a grass mulch, applied to the undisturbed bare soil of the drain-gauge after drainage at the 10 inch level had ceased, improved the percolation to such an extent that as much as 61 per cent of a storm of 1·5 inches drained through at the 10 inch level. Further studies are now being conducted with various superficial treatments of the soil. Present indications are that a stone or grass mulch on a flat bare surface greatly improves the soil percolation rate and results in little run-off except in very heavy storms*.

Crop Husbandry

BY

A. N. PRENTICE.

The crop husbandry programme was inevitably greatly influenced by the fact that all land is recently opened from rest, and there will be no representative range of fertility levels available for several years. The experience of the season has, however, clarified the agricultural problems of the area considerably. It is evident that the features which single out Buganda as an area for intensive farming—good rains, a double growing season and good soil—set the farmer an exacting task if he is to make the best use of them. The very fact of double cropping means that the timing of operations has very little safety margin, and if an opportunity is missed (as opportunities are in farming) or does not present itself, a half year's crop may well be reduced or even lost. Mechanisation seems more likely to help through timeliness than through more efficient tillage or cost-reduction. The importance of quick-maturing crops for the non-cotton portion of the year is obvious, and work on maize, an increasingly popular crop in the locality, is being directed at this stage mainly to selection for quick maturity, and to tests on the practicability of harvesting the crop before it has gone full term. What might be called the organisational aspect of rotation sets very real limits to the degree of "formal elegance" that can be introduced into rotation trials.

* The potential importance of these findings is very great. For instance, only 0·12 in. of run-off from grass mulched plots was recorded in a storm of 1·51 in. which fell in 30 min. and reached a peak rate of 10·5 in. per hour. If percolation can be maintained at this level under mulches, the question of the need for grass leys of long duration to restore soil structure will require reconsideration.

Soil Conservation.—As a basic system to make the soil safe pending the accumulation of data on soil and water behaviour, cultivation is at present restricted to land with a 6 per cent slope or less, in strips across the contour of 103½ ft. wide, and tie ridged. On the advice of Mr. C. Maher, then head of the Kenya Soil Conservation service, who visited Namulonge in 1950, an additional safeguard in the form of diversionary ditches at, generally, every fourth strip, is included in the protective system. On one year's experience it appears that tie ridging is an effective check on erosion if well done, and that on newly broken lands it leads to no better yields than flat cultivation in the initial crops.

Permanent Cultivation Experiment.—This was laid out in 1950, and covers eight acres, half under a perennial crop (bananas, kindly supplied by Kawanda) and half under arable crops. The individual plots are large, 108 ft. by 100 ft., to allow of field-scale observation and measurement of run-off, etc. ; the experiment is sited on a brow to give a range of slopes from 6 per cent to 10 per cent. The basic comparison is flat versus tie-ridged cultivation, and the opening cotton crop gave a 7 per cent, but non-significant, yield difference in favour of flat. The absolute yield-level was satisfactory, averaging 1,182 pounds per acre seed-cotton.

The bananas section of this experiment was successfully established; half of each plot was underplanted to cotton—a local custom, applying to a not inconsiderable fraction of Buganda's cotton acreage—and for an August planting the yield of this was good at 700 lb. seed cotton per acre, with flat and tie-ridging showing no difference. The bananas in the intercropped areas were obviously depressed in growth compared with those without competition, but no banana yields are yet available. In this, the first year, run-off was negligible, even on the steeper plots.

Other Conservation Trials.—A flat versus ridged comparison, laid down in 1949, gave no difference at a level 1,250 lb. per acre of seed-cotton. A compromise in the 1950-51 season, planting flat and then ridging as the cotton developed, was thoroughly satisfactory under this season's conditions of light planting rains, over a 4-acre stretch of new land : no wash took place while the land was still flat, the tied ridges played their part in holding the heavier later rains, and the time saved at the rush season by deferring the ridging operation and by machine-planting on the flat was important.

Another approach to soil and moisture conservation, namely mulching with elephant grass and other straw, was tried on a field scale, primarily to gain practical experience in the handling of mulches. Mulch, applied to ridged and flat cotton about a month after an August planting, again on new land, led to a measurable depression in growth (height) and by the end of the year to a noticeable yellowing of the foliage. Flowering rate appeared to be little affected, however, and yield differences, both on the flat and on the ridge, were unimportant.

Miscellaneous.—Work on grasses includes studies of methods of establishment of *Chloris gayana* leys and the collection and appraisal of other possibly useful grass species.

The soils of the Permanent Cultivation Experiment were sampled by Mr. M. A. Shatry, a Makerere Chemistry student, as a vacation task.

Full scale rotation trials are still in the discussion stage.

Entomology

by

E. O. PEARSON.

Yield figures given in other sections of the report show that no unusual damage from pests was suffered by the main cotton crop on the station. The incidence of *Lygus* damage varied greatly in different fields and was not generally severe. Even in the worst affected areas, which were those earliest planted, the yield of bulk plots of BP52 ranged from 700 to 1,000 lb. seed cotton per acre. *Helopeltis* attack was sporadic on earlier plantings, but not serious. Damage by false codling moth (*Argyroploce leucotreta*), pink bollworm and spiny bollworm was slight, and overshadowed by that due to American bollworm (*Heliothis armigera*). The latter has not been thought serious in Uganda, but some fields on the station suffered sharp attacks. Maize enters substantially into our rotation as a main rains crop and is being increasingly grown in Buganda : it is obviously suspect as an initiator of the infestation and the situation will need study. Cotton stainers were not common until right at the end of the season when they bred up to large numbers in some fields. *Dysdercus nigrofasciatus* predominated over *D. superstitiosus*, and *D. fasciatus* and *D. cardinalis* also occurred. Very little *Empoasca* was seen, even on relatively glabrous varieties : another jassid* was one of the commoner insects in swept collections but did no damage. Occasional examples of acariose were seen at Namulonge, and at the Agricultural Department station at Serere one field showed a pronounced effect. The condition is due to the mite *Tarsonemus latus* and it has not been recorded before on cotton in this country. The possibility of its status being affected by insecticides must be kept in mind.

All the experimental work of the section was concerned with the problem of *Lygus*. An essential aid to study is a way of estimating populations. Previous workers have used sweeping nets ; using this method, figures of from 6 to 8 *Lygus* adults per 100 sweeps were obtained in late August-September, on the cotton showing the worst damage. At the same date the control (unsprayed) plots in the *Lygus* - blackarm experiment were showing index figures of from 2 to 4 per 100 sweeps. These figures are of the order quoted by Darling (1947) for Kawanda in 1945.† That year was regarded as showing comparatively little

* Not yet identified, but probably a species of *Agallia*.

† His peak figure of 8 per 100 sweeps was obtained with a larger net.

Lygus damage. At Serere, in Teso district, where *Lygus* damage is much more severe than in Buganda, index figures of up to 40 have been recorded.

Sweeping is essentially a sampling method, and in an attempt to find what relation the sample bears to the absolute population, a small area of the worst damaged cotton was swept 15 times in succession at approximately 10 minute intervals. The first five collections showed no appreciable downward trend, the average catch being 2·4 per 100 sweeps, and although the numbers diminished in later collections, they had only fallen to half their original figure in the final collection. Numbers were too small to be able to fit a curve to them and so obtain an absolute figure for population by integration*, but the crude data showed that the true *Lygus* population may be at least 10 times that disclosed by a single sweep.† The point has important implications and will be further studied in conjunction with methods planned to obtain the total insect population of the plant.

Lygus vosseleri was the commonest Mirid collected ; other species of *Lygus*, and *Megacoelum apicale* and *Creontiades* were relatively rare, but two species of *Deraeocoris* occurred in numbers comparable with those of total *Lygus* during much of the season. These are said to be predators and their status needs examining. One of them superficially resembles *L. vosseleri* and this complicates the sorting of catches. Nymphs of *Lygus* were collected only in relatively small numbers on cotton, but large populations of both adults and nymphs of *vosseleri* occurred on *Eleusine*.

The main difficulty in studying *Lygus* is to measure the damage it does. The usual method has been to estimate leaf damage on the top leaves, or the whole plant. Two variants showing promise are periodic estimates on the 3rd to 5th leaves from the top of the main stem, the first two being excluded to avoid comparisons between leaves at different stages of expansion, and gradings, which can be made at long intervals, of every leaf on the main stem, the latter constituting its own time scale. A series of arbitrary standard grades of damage has been prepared.

The damage done to leaves, however, is probably less important than the loss of fruiting points and alteration of structure which *Lygus* causes. These effects can only be estimated by some form of plant analysis, which means accumulating and analysing very large amounts of data. Only the simplest form was attempted this season, namely, the total number of branches, classified as primary monopodia or sympodia, with the total number and fate of flower buds borne by each class. Some idea of the form of badly affected plants is given by analyses of the earliest plantings, in which the average number of flower buds formed per primary sympodium was less than 3, and of all those formed up to the beginning of December 90 per cent were shed.

* This operation was, however, carried out by Mr. Manning with figures obtained simultaneously for a Chrysomelid beetle.

† Even this only gives a population per acre of some 1,400 adults, or about 1 per 5 plants. It is thus extremely difficult to get adequate samples from experiments without using unduly large plots.

Quantitative measurements of damage which takes the form of missing or altered structures obviously cannot be made except by comparison with normal plants. It should be possible to get such comparisons by protecting plants from *Lygus* attack with insecticides. A combination of *Lygus* control with bacterial blight control should make it possible to study the relative effects of the pest and the disease, the precise status and interaction of which are debatable. Experiments on these lines were initiated this season by the Department of Agriculture. The companion experiment carried out here, which was expanded to include 5 varieties* was largely exploratory. Control of *Lygus* was attempted by weekly sprayings with DDT† and seemed quite successful as measured by *Lygus* sweeps and leaf damage counts, although the attack was not at all severe on the experiment as a whole. Attempts to vary bacterial blight infection by seed treatment did not succeed, and field blackarm was never serious, but spraying with suspensions of cultures of *Xanthomonas* (kindly supplied by Dr. Wickens) on 10-week old plants induced a typical blackarm attack of moderate intensity. A split plot design was used, to avoid interference between main treatments, but clear-cut differences at the junction of these showed such interference to be slight, and the design unfortunately resulted in much loss of precision. Large differences in response occurred between the halves of the experiment sited (through force of circumstance) on different parts of the station, and although on one half of the experiment treatment effects occurred which, it was generally agreed, were evident to the eye, over the experiment as a whole the only yield effect which could be shown to be statistically significant, apart from straight varietal effects, was an overall superiority (about 25 per cent) of the treatment protected from *Lygus* and without induced blackarm. But it was clear from the analysis that, with an improved design to give greater precision, experiments of this type can give valuable information not only on the direct effects of the pest and the disease, but also on the interaction of the two, and on the differential response to each of different strains of cotton.

The use of insecticides for the control of *Lygus* will be extended as a valuable technique for the study of more general aspects of the problem. Work on insecticidal control *per se* is being carried out by the crop insecticides unit of E.A.A.F.R.O., represented by Mr. McKinlay, who reached Namulonge at the end of the season.

Plant Pathology

BY

G. M. WICKENS.

Bacterial Blight (*Xanthomonas malvacearum*).—The success of projects for breeding cottons resistant to bacterial blight depends on the development of efficient inoculation techniques. For this purpose three possible methods of obtaining a uniform seed infestation were

* MU8, A2106, S47 and two selections for divergent habit out of BP52.

† 2 lb. of 50 per cent DDT wettable powder in 100 gals/acre applied by pressure knapsack sprayers at 50–110 lb. per square inch starting 7 weeks after planting.

tried on a range of strains carrying various combinations of resistance genes. All seed was acid delinted, and the following infestation techniques were used :—

1. Soaking seed in an infected leaf debris suspension.
2. Coating seed with bacterial slime from a culture.
3. Soaking seed in a heavy suspension of bacterial culture.

After all treatments the seed was dried in the laboratory.

The following strains were used :—

Resistance genes.	*Strains.**
$B_1 B_2 B_3 B_3$	BAR7/8.
$B_1 B_2 b_3 b_3$	BAR7/1, BAR7/3, B181, UA7–57
$b_2 b_2 b_3 b_3$	SUS7/2.
American resistant	Stoneville 20.
Mixed for resistance	Funtua Allen.
Uganda standard	BP52/3MB.

Inoculation with leaf debris suspension proved entirely ineffective. The two treatments involving the use of cultured bacteria, on the other hand, gave useful results. Data are summarised in Table 3.

TABLE 3.
RESULTS FROM SEED INOCULATION.

Record.	*Emergence at 13 days (% of control).*		*Severity at 22 days.**		*Percentage free from all phases at 48 days.*		*Percentage free from main stem lesions at 140 days.*	
Method of Seed Inoculation.	*Slime.*	*Suspension.*	*Slime.*	*Suspension.*	*Slime.*	*Suspension.*	*Slime.*	*Suspension.*
BAR7/1 ...	89	103	+2·9	+1·1	28·2	2·9	73	47
SUS7/2 ...	85	96	+0·4	0·0	1·5	1·5	41	36
BAR7/8 ...	92	103	+2·8	+2·9	24·6	15·5	57	67
BP52/3MB	83	88	+1·0	−0·8	3·2	4·8	49	36
B181 ...	91	97	+2·3	−0·8	10·5	0·0	73	50
Stoneville 20	88	89	+1·8	+0·1	58·0	43·1	77	69
Allen ...	65	81	+1·3	−1·1	27·3	12·3	65	35

* Estimated by grading cotyledon lesions on a scale of 3 for healthy seedlings, 1 for slight infestation, −1 for severe infection, and −3 for very severe infection.

In comparing first the two methods of inoculation, it is seen that while coating with bacterial slime caused greater pre-emergence mortality than soaking in bacterial suspension, it caused on average less disease in the emerging seedlings and in the plants remaining after thinning. Suspension soaking thus appears the better for general practice, the method being more uniform in action within any one strain, and giving less chance of escape from disease.

In comparing the strains, the most important results are : (*a*) the high degree of escape of BAR7/8 (B_2B_3) from cotyledonary infection under both methods of treatment, with BAR7/1 (B_2) and SUS7/2 (b_2b_3) generally following expectation ; (*b*) the failure of Stoneville 20 to show the high degree of resistance to cotyledonary infection reported in the U.S.A. (Weindling 1948), but (*c*) in spite of this, its relative freedom from later secondary infection and from damaging main stem lesions. Allen shows, as expected, a wide range of susceptibility.

* The BAR and SUS strains are Sudan strains bred by Dr. R. L. Knight.

Foliage sprays using leaf debris inoculum prepared and applied by Knight's method proved only very slightly effective, as did also a suspension prepared from bacteria grown in pure culture, dried and stored in the laboratory for one month.* Suspensions of bacteria from agar cultures were invariably highly effective. Weindling's (1948) technique of application, which he found induced main stem lesions on young seedlings, caused blackarm on only a disappointingly small proportion of plants.

The first appearance of lesions on BAR 7/8 (B_2B_3) was delayed, and drying of the watersoaked spots was more rapid than on other strains. As at Barberton, however, the method was inadequate for distinguishing between B_2 and b_2 genotypes. Records were taken of the subsequent development of the disease in plots to which foliage sprays were applied. Stoneville 20 was consistently and markedly superior to the rest, the three B_2 strains coming next in order (B_2B_3 was not included in this section of the trial).

Inoculations designed to give a direct measure of resistance of stem tissues to *X. malvacearum* have given conspicuously good results.

Agar plate cultures were used. Bacteria were introduced into the stems, either with sewing machine needles, or by atomising suspension on to scratches. Alternatively, terminal buds were either brushed or forcefully sprayed with a strong water suspension of bacteria. 60 days after inoculation the plants were graded for severity of the resultant main stem lesions into 4 grades from 0 (no lesions apparent) to 3 (very severe lesions causing destruction of any growth made above the point of inoculation). Records are summarised in Table 4.

Table 4.

Mean Scores for Severity of Lesions Arising From Main Stem Inoculation.

Strain.	*Method of Inoculation.*	
	Stem wounding.	*Bud brushing and spraying.*
BAR7/1	1·92	0·68
SUS7/2	2·14	0·81
BAR7/3	2·05	0·77
BP52/3MB	1·63	0·82
B181	1·87	0·70
Stoneville 20	0·14	0·25
UA7–57	2·19	1·49

Stem wounding was much superior to the bud brushing and spraying methods. Under all methods of inoculation, Stoneville 20 was strikingly the least affected. There is little between the others except that UA7-57 was appreciably the worst affected by bud brushing and spraying. There is no evidence of B_2 conferring any appreciable resistance to stem tissues in this experiment. Data from a later needle prick inoculation series, made at 83 days and graded 72 days later, are

* Subsequent experiments on the use of dried bacteria have given some promising results, and this method of storage has distinct possibilities.

summarised in Table 5. Slightly more precise grading was adopted here, from 0 (no visible symptoms) to 4 (very severe).

Table 5.

Frequency Arrays and Means for Severity of Main Stem Lesions Arising From Stem Inoculations at 83 Days, Graded 72 Days After Inoculation.

Strain.	Grade.				Mean.
	1.	2.	3.	4.	
BAR7/1	7	11	10	8	2·53
SUS7/2	2	10	12	10	2·88
BAR7/8	14	15	4	1	2·06
BP52/3MB	5	9	11	9	2·71
B181	2	12	13	7	2·74
Stoneville 20	25	7	1	0	1·27
Allen	14	10	7	7	2·18

In this experiment, Stoneville 20 appears once more as highly resistant. There is evidence also of a useful measure of resistance in BAR 7/8 (B_2B_3), and of wide variation in Allen with a fair proportion of resistant plants.

The needle-prick method of inoculation offers much promise as a means of determining inherent resistance to perhaps the most destructive phase of bacterial blight. Inoculations can be made rapidly, and grading of the extent of resulting attack is also rapid and simple. With improved standardisation of the technique, it may well prove possible to use the method with certainty not only in comparing strains but also in determining the genotype of single plants.

The importance of bacterial boll disease infections arising at the extreme base of the boll has been discussed earlier (Wickens, 1942), and an attempt was made to test the susceptibility of the young boll at about the time of flower drop. Strong water suspensions of bacteria were used, and were either poured or atomised into the yellow flower, or were atomised into the calyx cup, or on to the base of the bracts, within and without. Inoculated flowers and bolls were date-tagged. All methods were successful in inducing considerable boll disease, principally at the base as found in natural infections. Atomisation into the calyx cup was the most successful, with atomisation into the bracts at flowering next.

2,608 flowers and young bolls were thus inoculated. Unfortunately there was nearly 40 per cent shedding, much of it from causes unrelated to the experiment. The surviving inoculated bolls were collected when dry and graded in the laboratory with the following results (Table 6).

Table 6.

Severity of Bacterial Boll Disease Resulting From Flower and Young Boll Inoculations. (Results From all Methods Grouped.)

Strain.	% of bolls in which lint was not affected.	
	As % of bolls retained.	As % of flower or bolls inoculated.
BAR7/1	12·7	8·0
SUS7/2	21·1	11·4
BAR7/8	12·9	7·4
BP52/3MB	44·1	18·4
B181	27·0	13·9
Stoneville 20	44·4	19·7
Allen	16·1	8·2

Stoneville 20 and BP52 are clearly the least severely affected, with B181 the best of the remainder. There is no evidence of the B_2 or B_3 genes conferring any degree of resistance to this form of attack.

Summarising the information on varietal differences in resistance, the behaviour of Stoneville 20 is particularly noteworthy. It has shown high resistance to all forms of attack, save angular leaf spot arising directly from foliage spraying and cotyledon infection arising from seed inoculation. It is pertinent to note that these forms of attack are, respectively, employed effectively in the Sudan and advocated in U.S.A. as criteria of resistance. On either, Stoneville 20 would have been ruled out on the results of these experiments, whereas it has in fact shown a higher level of general effective resistance than any other strain tested.

B_2B_3 (in BAR 7/8) has been shown to confer a high capacity for escape from seedling infection, and a measure of leaf and stem tissue resistance, but no resistance (indeed possibly the reverse) to bacterial boll disease. B_2 alone (in BAR 7/1) apart from conferring some degree of escape from seedling infection, and perhaps a small measure of stem tissue resistance, has been found to have little if any effect. This is in line with general experience in Uganda. BP52 (Modal Bulk stock) is notable in its resistance to bacterial boll disease, about equal to Stoneville 20 in this respect.

It is evident that resistance to one form of attack does not necessarily imply resistance to others, and it follows that at present no single criterion can be advocated, under Uganda conditions, as a measure of effective resistance to the disease.

In a subsidiary experiment a number of strains, mostly received from other territories, were tested for susceptibility by spraying with suspension from agar cultures. Of particular interest was the group of strains from Dr. R. L. Knight, carrying between them all the known resistance genes so far recognised as operative in the Sudan. The strains tested were as follows :

BAR4/16	(B_1B_3) X 1730	From Dr. R. L. Knight, Sudan.
BAR4/18	(B_1B_6m) ,,	
BAR14/7	(B_1) Sakel	
BAR14/9	(B_2) ,,	
BAR14/11	(B_1) ,,	
BAR14/22	(B_5) ,,	
BAR14/19	(B_4) ,,	
BAR14/21	(B_1B_3) ,,	
Rex 4710 / Rex 474	... ...	From Mr. H. E. King, Samaru, Nigeria.
UA8–48 / BAR17/1 = UA8–48/49 S		"Albar" from Dr. Hutchinson.

BAR 4/18, UA8-48 and BAR 17/1, BAR 4/16, BAR 14/21 and BAR 14/9 appeared resistant, in that order. There were no typical angular leaf spot lesions on BAR 4/18. In the other resistants the spots, although sometimes numerous, were very small and quickly dried out. Fewer leaves also were affected than in the susceptibles. Later in the season all strains were scored for severity of main stem lesions, from 0 (no lesions) to 3 (very severe lesions, girdling and

killing the stem). BAR 4/18, UA8-48, BAR 17/1, Rex 4710 and Rex 474 showed no lesions. Of the remainder, there were 11 plants in grade 0, 71 grade 1, 62 grade 2 and 62 grade 3.

The virtual immunity of BAR 4/18 to leaf infection and secondary stem infection in this experiment is particularly striking in view of the fact that *barbadense* types usually suffer considerably more than comparable Upland material. It is, however, in line with Knight's expectation (personal communication), and indicates the great potential value of this gene combination on suitable Upland genotypes.

" Albar " and the Nigerian strains also remained remarkably free from blackarm ; the latter the more remarkably because they had suffered severe angular leaf spot infection. In view of the high resistance of " Albar ", which was a single plant selection from ginnery seed of Nigerian Allen, an attempt was made to secure more variable material of high bacterial blight resistance by selection in a plot of Allen subjected to periodical *X. malvacearum* infection. Some 6,000 seeds were inoculated by coating with bacterial slime from agar cultures, and sown thickly. This resulted in severe cotyledonary infection in many of the seedlings and also no doubt to considerable pre-emergence mortality. This was followed on the 25th day by forceful foliage spraying with strong bacterial suspension, and on the 42nd day the plot was rogued, leaving only 88 seedlings showing relatively little attack. On the 85th day these plants were again sprayed, and 14 days later the plot was again rogued, leaving 39 plants showing little infection.

An elaborate experiment was laid out to study the effect of various plant sanitation methods and agricultural practices on the carryover of infection from season to season. Though there was considerable infection on volunteer seedlings appearing in the main rains, there was no evidence of carryover from one cotton season to the next, other than what could be accounted for by infected seed.

Verticillium Wilt Disease (*V. dahliae*).—Work on this disease at Namulonge has been confined to the testing of a number of strains for resistance. The stem wound inoculation method developed at Barberton was used, and a sufficient range of material has now been tested to give confidence that reaction to artificial stem inoculation will accurately indicate the relative behaviour of strains under natural infection. Moreover it has been found possible so to organise the work that over 800 plants were inoculated in a single morning, with practically 100 per cent. success. Plants were graded 15-18 days after inoculation, as follows.

Grade 1. Not more than two leaves showing symptoms.

Grades 2 and 3. Intermediate.

Grade 4. All of the plant showing symptoms, all leaves being affected up to the tips of all shoots with the possible exception of one shoot near the base of the plant arising from the side opposite to the point of inoculation.

Two series of strains were examined for wilt behaviour. The first included a range of strains known from previous experience to cover a wide range of resistance and susceptibility while the second comprised a group of hybrid progenies, of wilt resistant B181 × susceptible BP50 ancestry, supplied by Mr. J. D. Jameson. Data for strains are summarised in Table 7, and for hybrid progenies in Table 8.

TABLE 7.

Verticillium WILT RESPONSE OF REPRESENTATIVE STRAINS.

Strain.	Wilt grade.						Remarks.
	1.	2.	3.	4.	Total.	Mean.	
S47	5	8	6	1	20	2·15	Uganda susceptible.
BP52/2MB	20	31	51	21	123	2·59	Uganda partly resistant.
B181	13	12	11	2	38	2·05	Uganda resistant.
KP28...	7	6	6	1	20	2·05	Uganda resistant.
Acala 29–4	5	9	5	1	20	2·10	U.S.D.A. resistant.
Acala 29–6	8	7	4	1	20	1·90	U.S.D.A. resistant.
MU8a	3	6	16	13	38	3·30	Indian American.
Tidewater	2	5	13	1	21	2·62	U.S.D.A. Upland
U4/8161	0	1	4	15	20	3·70	Barberton U4.
V135	20	0	0	0	20	1·00	St. Vincent Sea Island.
C9363	2	3	12	3	20	2·80	Indian Cambodia.
A791	9	5	5	0	19	1·79	MU8a × Tidewater.
A5805–06	3	7	10	0	20	2·35	MU8a × Tidewater.
A618	0	4	8	8	20	3·20	MU8a × BP52².
A7261	2	3	10	5	20	2·90	MU8a × BP52².
A6446	10	2	6	2	20	2·00	U4/8161 × V135.
A7834	2	5	9	4	20	2·75	U4/8161 × V135.

V135 showed very uniform very high resistance, no more than about 2 leaves on any plant at any time showing slight symptoms. B181 and KP28, and the two Acala strains, were predominantly resistant, but contained a proportion of susceptibles. For breeding work, preliminary selection is necessary.

BP52/2MB was very variable, giving promise of yielding by selection strains with a good measure of resistance. S47 (the derivative of BP50 in commercial cultivation) has shown an unexpected measure of resistance on this grading ; later observation showed however that this was rather flattering, although the strain generally still appeared appreciably more resistant than others such as MU8a and especially U4/8161.

C9363, MU8a, Tidewater and U4/8161 were all predominantly susceptible, the latter being the most severely and uniformly affected. A791 and A5805-06 both showed a higher general level of resistance than either of their parents (MU8a and Tidewater). A618 and A7261 (MU8a × BP52²) have shown little if any of the resistance of the Barberton selection of BP52 from which they are descended. A6446 and A7834, especially the former, show evidence of possessing some of the resistance of their Sea Island parent, but to a disappointingly small extent.

Selfed seed has been taken from a number of resistant plants, especially in B181, BP52, and the two Acala strains.

TABLE 8.

Verticillium WILT RESPONSE OF B181 × BP50 HYBRID STRAINS.

Progeny.	*Wilt grade.*					
	1.	2.	3.	4.	*Total.*	*Mean.*
H80 (S47 × KP28♀) F_1	0	0	7	12	19	3·63
H81 (S47 × KP28♂) F_1	0	0	0	19	19	4·00
H80 F_2	0	3	12	5	20	3·10
H81 F_2	0	2	9	9	20	3·35
H69 (KP28♀ × KP40♂) F_7 ...	1	2	5	12	20	3·50
DE711	2	7	8	3	20	2·60
DE712	1	8	4	7	20	2·85
DE713 Selections	1	4	8	7	20	3·05
DE714 from H69	0	1	7	12	20	3·55
DE715 F_6	1	7	7	5	20	2·80
DE717	1	2	13	2	18	2·89
DE718	1	4	10	5	20	2·95
Totals for H69 selections	7	33	57	41	138	2·96
BC115 (KP28 × KP40[3])F_2 ...	3	2	4	11	20	3·15
BC160 (DE × S47♀)F_2	0	0	4	16	20	3·80
BC161 (DE × S47♀)F_2	0	0	13	6	19	3·32
DE[3] 721/144	0	2	4	14	20	3·60
DE[3] 722/152	1	2	12	5	20	3·05

KP28 is a B181 derivative ; KP40 and S47 are of the BP50 family.

Clearly the mode of inheritance of resistance in the B181 family is complex, and progress in breeding and selecting for wilt resistance, in the absence of a satisfactory inoculation technique, has been very slow and uncertain. Adoption of the present technique will, it is confidently anticipated, lead to more rapid and certain progress.

Through the courtesy of Professor A. R. Pullen, now in charge of the Barberton station, it was possible to follow up in the 1950-51 season, the behaviour of wilt on the land on which a manuring trial was conducted in 1948-49 (see Progress Report for the Barberton station, season 1948-49). Full details of the experiment will be published later elsewhere ; for the present the main general results are reported, viz. :

Compost.—Good yields in the crop to which applied, even under severe wilt incidence, but increase of wilt stimulated in the succeeding crop.

Potash.—Good yields in the crop to which applied, even under severe wilt incidence, with increase of wilt retarded in the succeeding crop.

Superphosphate.—Poor yields (well below control) in the crop to which applied, and increase of wilt stimulated in the succeeding crop.

All these effects were generally independent and additive.

Opportunity was also taken to record wilt attack in a variety trial laid down by Professor Pullen on land heavily infested with *Verticillium* wilt with previously recorded wilt history. This gave evidence of little or no wilt resistance in a number of progenies of MU8a × BP52[2] and of U4 × Sea Island, of high resistance in B181, and of very high resistance in KP28.

Grateful acknowledgment is made here of the facilities and hospitality extended to me by Professor Pullen and by members of his staff.

Plant Breeding

BY

J. B. HUTCHINSON, D. MACDONALD AND H. L. MANNING.

Type Collection.—A representative series of types from the C.R.S. collection of the world's cottons was grown for observation, and was scored for *Lygus* leaf damage on a scale of 1=no visible damage up to 5=very severe. Data are summarised by species in Table 9.

Table 9.

Lygus Leaf Damage by Species : September, 1950.

Species.	Mean Grade.																			Total.
	1·0	1·2	1·4	1·6	1·8	2·0	2·2	2·4	2·6	2·8	3·0	3·2	3·4	3·6	3·8	4·0	4·2	4·4	4·6	
G. hirsutum	1	7	7	9	16	23	22	20	15	16	7	6	3	—	1	—	—	—	1	154
G. barbadense	14	28	19	12	14	14	17	9	6	2	3	2	1	—	—	—	—	—	—	141
G. arboreum	8	2	2	4	1	1	2	—	—	1	—	—	—	—	—	—	—	—	—	21
G. herbaceum	2	1	—	2	1	2	2	—	1	—	—	—	—	—	—	—	—	—	—	11

G. arboreum showed the least damage. Within the species there were considerable differences between areas. Four Chinese types gave mean damage indices of 2·0—2·8. No other type gave a mean above 1·8. On Uganda standards this ranks as very good resistance. The data must, however, be considered with caution, since most of the *arboreums* cropped badly, and it remains to be shown whether or not *Lygus* caused crop loss. *G. herbaceum* showed more damage, the only strains showing none being two African perennials.

Among the New World cottons, *G. barbadense* was superior to *G. hirsutum*. Of 141 strains listed, half gave counts of 1·6 or less. South American *barbadenses* were very susceptible. The least attacked groups were the perennials from the Antillean region and Central America, with the Sea Islands next. No *G. hirsutum* group was as good as the Sea Islands. The best was Indian Cambodia. Five types from French Equatorial Africa did well, but require further testing. The most variable group was the one containing Persian, Russian and Chinese Uplands.

A similar *Lygus* leaf damage count was carried out on a replicated trial of a number of MU8 hybrids. MU8 belongs to the Indian Cambodia group, and it was hoped to gain statistical evidence of segregation of type of response to the pest. BP52/2MB, which was used as control, suffered the greatest damage. There were significant differences between related strains in leaf damage index, and it may be concluded that differences between strains in this respect are real.

Barberton Material.—When the Barberton station was handed over to the Union Government, there was a wide range of plant breeding material, mostly of hybrid origin, in an advanced stage of development. The potentialities of this material for reselection under Uganda conditions appear to be considerable, and it was accordingly grown for study and for seed multiplication at Namulonge.

Final yields were generally good and in some cases approached those obtained in Barberton, but it must be noted that under the cool and cloudy conditions of Buganda it took eight months to produce the crop as against six months or less for the same strains in South Africa. The differences in crop maturation of a fortnight to three weeks exhibited between strains when grown in South Africa were much reduced in Uganda. The material falls into three quality groups, the U4's and crosses between U4 and strains of similar quality, inter-Upland crosses of which one parent was of high quality, and inter species crosses involving U4 and Sea Island.

The U4 quality group was grown for observation and maintenance only. None of the strains in this group was "happy" under local conditions though most of them fruited reasonably well. Considerable loss of crop was caused mainly by *Lygus* but also by bacterial blight after the *Lygus* attack had ceased. Though *Lygus* attack was sporadic it was sufficiently heavy to show that none of the strains possessed any real resistance to the pest.

Of the inter-Upland quality crosses the most important was the MU8 × BP52[2] material, of which 81 progenies ranging from the 1st to the 4th generation from the backcross were sown on the cotton section of the Permanent Cultivation Experiment (see Crop Husbandry section). Strict yield comparisons were not attempted in the first year, and the plots were not replicated. Yields were good, however, ranging between 762 and 1,713 lb. of seed cotton per acre, with a mean over 4 acres of 1,182 lb. Five parent bulks of this material planted in another area of the farm gave an average yield of 1,684 lb. of seed cotton per acre. Lint samples were examined by the staff of the Lint Marketing Board, and were classified as within the range of the BP52 strain in general cultivation.

The second inter-Upland quality cross was MU8 × Tidewater, of which 16 bulks were planted. These are big bolled types with boll weights varying from 6 to 7·5 gms. and under South African conditions tended to be later and much more leafy than any of the other hybrid strains. Contrary to expectation, and despite a rainfall of nearly 23 inches in the three and a half months following planting, the general plant habit developed was open and sympodial without any pronounced leafiness. A good early crop was set and held but damage to the later set crop was caused by American bollworm, bacterial blight and other diseases. Laboratory analysis of the lint characters of the selections taken out of these bulks show that while lint quality as judged on length and silkiness is generally good, and the lint index regularly

high, the range of ginning outturn is not very wide and is generally rather low, i.e. from 30 to 32 per cent.

It was not possible to plant the U4 × Sea Island cross until 25th August. Germination was good and plant growth and development during the first three months was much more rapid than that of July planted cotton. The progenies ranged from the F_4 to the F_9 generation and accordingly exhibited a wide range of plant habit, and many progenies were discarded on field observations. Later, a heavy attack of American bollworm was experienced, which destroyed most of the early and all the late crop. Final cropping was consequently so poor that it was only possible to carry forward bulks of progenies which were judged promising before the bollworm attack took place.

BP52 Material.—Seed for the fourth generation Modal Bulk (4MB) was selected using the same criteria as in earlier years, namely lint index, seed weight and lint length, and 175 plants were retained. The yield advance of these over the 500 examined, was about 1·7 per cent. Plotted data for cumulative yield advance suggests that the yield level of later modal bulks should reach a state of equilibrium in two or three seasons, at about 15 to 18 per cent above the original material. Ranges for the characters examined this season were 4·34 to 5·33 for lint index, 9·5 to 10·9 for seed weight and 32·0 to 35·2 for mean maximum lint length. One acre each of two promising strains C(48)4 and C(48)12 from the Small Bulks Trial of the previous season have been grown for modal bulk selection.

Replicated and non-replicated progeny rows were sown on June 12th, and made a good start. *Lygus*, blackarm and excessive rainfall during the period of flowering, caused unusually severe losses of early bolls. Later recovery, so characteristic of the BP52 variety, was delayed by the dry November and yield levels were consequently low. Morphological and seed cotton characters for some of the 29 progenies grown are summarised in Table 10.

TABLE 10.

SUMMARY OF MORPHOLOGICAL AND SEED COTTON CHARACTERS FOR SOME BP52 PROGENIES IN REPLICATED PROGENY ROWS. DATA FROM 5 REPLICATIONS OF 10 PLANT PLOTS (1/726 ac.).

1949 *Strain.*	1950 *Progeny.*	*Lygus Damage.*	*Days to Flower.*	*Components of Yield.*			*Lint Grms. per Plant.*	*Yield Equivalent lb. lint p.a.*	*Seed Weight.*	*G.O. %*
				Bolling Index.	*Seeds per Boll.*	*Lint per Seed Grms.*				
C(49)1	1	2·52	88·5	9·6	29·5	4·85	18·8	301	10·48	31·6
C(49)3	3	2·64	87·4	11·9	24·3	5·01	20·0	320	10·60	32·1
C(49)21	14	3·12	88·3	10·1	22·1	5·44	17·4	278	11·24	32·7
C(49)22	17	2·92	90·9	10·3	27·4	5·80	23·6	378	10·52	34·7
C(49)22	20	2·90	88·7	10·0	24·5	5·07	20·4	326	9·92	33·4
C(49)35	28	2·84	87·5	8·6	24·8	5·00	20·1	322	10·20	32·9
C(49)36	33	2·58	88·1	9·6	23·2	5·11	21·6	346	10·38	33·0
C(49)41	37	2·96	90·5	12·2	23·4	4·40	21·2	339	9·76	31·1
	Bulk	2·78	86·2	7·2	23·7	4·66	14·3	229	10·18	31·4

Final selection of progenies was based on indices calculated from the discriminant function technique, where lint per plant was the

desired aim. With a selection differential (z/q) of 1·40 (for 6/30 progenies), the expected genetic advance, either from direct or indirect estimates of genetic net worth, was between 9 and 10 per cent.

Data from a Small Bulks Trial of the best of last year's progenies are given in Table 11 where it is shown that the mean yield advance of the six selected at the end of the previous season, is about 6 per cent over 2MB. The picking curves show appreciable differences in maturity, particularly for the C(49)16 strain of which 60 per cent of the crop was reaped before the end of the year.

Table 11.

Small Bulks Trial 1950/51—Seed Cotton Characters for some Selected Strains. 5 Replications of 1/50 ac. Plots.

Line.	*Strain.*	*Cumulative seed cotton yields per acre as percentages of total.*							17/2/51 *Last pick.*	*G.O. %*	*Lint per Acre.*
		30/11/50	11/12/50	20/12/50	28/12/50	8/1/51	22/1/51	31/1/51			
C(48) 2	C(49)3	6	13	25	40	56	78	93	815	33·7	275
C(48)29	C(49)30	7	16	28	46	62	80	93	773	34·6	267
C(48)13	C(49)25	8	14	27	42	57	78	93	751	34·3	258
C(48) 8	C(49)14	11	19	34	49	61	78	92	771	32·5	250
	C(49)16	15	26	44	60	72	85	97	768	32·7	251
C(48)34	C(49)34	8	17	32	42	56	77	92	713	34·5	246
2 NL 49/50	2MB	9	18	34	51	65	83	97	702	33·2	233

Lint samples from the promising strains C(49)3, C(49)30 and C(49)25 have been sent to the Shirley Institute for large scale spinning tests. In addition C(49)3 will be tested in the District Variety Trials, which provide a wide range of environmental conditions throughout Buganda.

Strains bred under the comparatively favourable conditions of experiment stations must be rigorously tested under the conditions of commercial cultivation. Such testing is carried out by the Senior Botanist in the Agricultural Department, by whom data were supplied for an analysis of the behaviour of Namulonge strains in the BP52 producing area. These were analysed not only to compare the overall behaviour of Namulonge strains against BP52 but also to investigate any possible variety × locality interactions.

This season—the first during which selected strains from Namulonge were tested—13 separate trials in 5 × 5 Latin squares were conducted. Statistical analyses of yield data showed that varietal differences could be regarded as significant at four localities only. At Namulonge, Bukalasa and Kalagala the Namulonge C(48)12 strain significantly outyielded the BP52 strain, and at Kamenyamigo BP52 significantly outyielded the S47 strain—now the standard for the area east of the Nile—and the Namulonge strain, C(48)4.

The variances of the 13 trials were highly heterogeneous and it was therefore impossible to use a serial analysis of variance, in investigating the importance of variety × locality interaction. Some trials were obviously unsatisfactory, but it was clearly desirable to make use of as many as possible, and if any were to be discarded, to discard on some objective criterion. The nature of the distribution of plot yields seemed to meet this need, and three trials in which the plot yield distributions were obviously asymmetrical were omitted. On one of these a row of plots had been burnt and in the others yields varied from 145 to 1,445 lb. per acre, and from 170 to 1,100 respectively. Average seed-cotton yield levels of trials at these three centres over a number of seasons were 1,073, 923 and 882 lb. per acre, so that they represent the centre portion of the range of yield for all district variety trials. Even then the heterogeneity of variances necessitated a weighting according to a least squares method given by Cochran and Cox (1950). Actual yields and weighted data are summarised in Table 12.

Table 12.

Sowing Date and Comparative Lint Yields of Strains in District Variety Trials—Mean Weighted Yield at all Localities.

Variety	*Sowing Dates at Localities.*										*Variety Means at all Localities.*	
	July 4	*July 14*	*June 29*	*June 30*	*July 4*	*July 19*	*July 17*	*June 28*	*Aug. 6*	*July 21*		
	Bukomero	*Bukalasa*	*Kamenyamigo*	*Namulonge*	*Mukono*	*Kalagala*	*Namyoya*	*Kawanda*	*Kakumiro*	*Bulindi*	*Actual*	*Weighted*
BP52	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
2MB	97·3	99·7	94·0	107·5	104·6	107·2	97·1	96·9	87·6	153·0	100·8	100·1
C(48)4	94·8	94·6	89·2	107·9	102·3	100·0	91·6	88·2	76·7	114·8	95·1	95·3
C(48)12	103·5	115·3	95·9	119·9	113·4	121·3	96·2	116·0	95·3	119·1	108·4	107·3
S47	104·4	101·8	92·1	94·2	105·0	106·0	101·7	108·8	103·6	119·1	101·8	101·8
Locality lb.p.a.	636	529	517	408	361	351	306	251	236	147	376	
S.E.%	3·7	6·3	7·5	7·4	13·1	11·4	9·6	19·1	15·7	24·3		
L.S.D. as % BP52	5·2	8·9	9·8	10·8	18·9	16·8	12·8	26·7	20·0	45·3		
wi	38·46	19·42	14·53	23·62	9·71	13·48	25·32	9·40	15·96	13·79 *		

Significance of Increment over BP52 control thus—

* 4 Replications only.

Unadjusted mean lint yields show that C(48)12 is about 8 per cent better than BP52 under the range of conditions represented by these ten localities. On the weighted means C(48)12 is shown to be about 7 per cent better than BP52. The regression of mean values for C(48)12 and BP52 on locality means show that this average increase was made up by a 17 per cent increase of C(48)12 under the less favourable growing conditions (132 lb. lint/acre), which are more typical of peasant holdings, falling to 7·2 per cent at the higher yield levels (528 lb. lint/acre). Clearly the yield advance of this bulk of an

early selection over the standard BP52 justifies the anticipation of further advance with more recent selections.

There has been some uncertainty as to whether yields from the District Variety Trials do in fact give a representative estimate of yields obtained by the peasant. Peasant seed cotton yields derived from Provincial production are estimated at from 600 to 300 lb. per acre when 50 per cent of the cotton acreage is sown between early July and early August. Using data from 151 trials conducted over 16 seasons, the relationship between sowing date and yield was analysed to obtain further information on yield levels at various sowing dates for comparison with conditions on peasant holdings. Fiducial limits (9 : 1) were calculated for yields at 12 day groupings for which the central date is shown, and are summarised in Table 13.

TABLE 13.

9:1 FIDUCIAL LIMITS OF SEED COTTON YIELD OF BP52 AT VARIOUS SOWING DATES.

(DISTRICT VARIETY TRIALS 1935/36 TO 1950/51.)

	May 6	*May* 18	*May* 30	*June* 11	*June* 23	*July* 5	*July* 17	*July* 29	*Aug.* 10	*ALL*
Upper ...	—	1,497	1,876	1,660	1,861	1,720	1,789	1,372	1,086	—
Lower ...	—	411	272	378	711	608	391	430	166	—
Mean ...	705	954	1,074	1,019	1,286	1,164	1,090	901	626	1,044
C.V. % ...	—	30·5	40·2	35·6	25·8	27·9	38·2	30·3	39·5	—
n ...	4	9	9	14	20	25	39	20	9	149

Two very late trials eliminated (August 22nd ; September 4th).

The mean yield of BP52 under these conditions was about 1,040 lb. seed cotton per acre, and from the fiducial limits it may be seen that crop risk is least when sowing is confined to the relatively narrow period from the middle to the end of June. Since the lower limit of the next period is still reasonably good, the best sowing period may be regarded as extending from early June to the third week in July. Moreover it appears that the lower limits of yield in variety trials, particularly of later sowings, overlap the yields experienced in peasant holdings. It may be inferred that agronomic practices generally are at a higher level on the trials than on peasant areas, thus accounting for the higher mean yields, but that under unfavourable conditions the same minima have been obtained.

The origin of the BP52 material has been discussed in previous reports, and the mean lint yield of the 437 plants grown at Kawanda in 1946-47 may conveniently be taken as a standard at 100 per cent. The first modal bulk was found to have an increment of 7·8 per cent on this standard, the second 3·2 per cent on 1MB and the third 3·1 per cent on 2MB. Therefore when any of these are used as controls Bulk = 100; 1MB = 108; 2MB = 111 and 3MB = 115. The most recent bulk 4MB is estimated to be 1·7 per cent better than 3MB. This suggests that the cumulative advance, considerably reduced in later stages, is not likely to be much in excess of 16 per cent. When such a bulk has finally been obtained, it will be invaluable for use as a control. However in the meantime the estimation of yield advance must be judged by the standards available.

Expected and actual lint yield advances in the various stages of the breeding programme are summarised in Table 14.

TABLE 14.

YIELD ADVANCE AT VARIOUS STAGES OF THE BP52 BREEDING PROGRAMME.

1946-47 STANDARD GIVEN AS 100 PER CENT.

Season.	*Number of Strains.*	*Standard Strain.*	*Net Value.*	*Expected Advance*		*Actual Advance.*		
				%	*Net Value.*	*%*	*Net Value.*	
1. Replicated Progeny Rows.								
1948-49 ...	48	1MB	108	—	—	+12·1	120	—
1949-50 ...	48	2MB	111	12·2	112	− 2·1	109	—
1950-51 ...	29	Bulk	100	3·8	116	+25·6	126	—
2. Small Bulks Trial.								
1949-50 ...	4	1MB	108	—	—	8·0	116	—
1950-51 ...	6	2MB	111	—	—	6·1	122	—
3. District Variety Trial (Namulonge Unit).								
1949-50 ...	5	BP52B	?=100	—	—	14·0	114	1MB
1950-51 ...	5	BP52 Bulk	?=100	—	—	7·0	107	2MB
						8·0	108	C(48)4
						21·0	121	C(48)12
4. District Variety Trial (Ten Localities).								
1950-51 ...	5	BP52 Bulk	100	—	—	9·9	110	C(48)12
5. Acre Bulks.			Lint p.a.					
—	—	3MB	269	—	—	—	115	—
—	—	C(48)4	280	—	—	—	120	—
—	—	C(48)12	363	—	—	—	155	—

These advances, achieved in the early stages of the breeding programme, indicate that variability in yield characters in BP52 is still high enough to be exploited in progeny row breeding. The yield advance in the District Variety Trial stage, of the order of 10 per cent, would of course represent a large increment over the whole Province. However since the quality of the strain concerned is at the lower end of the BP52 range it is premature to consider it for large scale bulking, though its relatives may be expected to lead to a general improvement in yield on standard BP52.

PROGRAMME

The broad programme of the station was discussed at length in 1950, and will hold good for some years. The rate of development of the cropping area will be limited by the current acute labour shortage, and all parts of the programme that can be mechanised will be modified to minimise the amount of hand labour necessary.

REFERENCES :

Trumble, H. C. (1937), Trans. Roy. Soc. Aust. 1937, 61.
Farbrother, H. G. (1951), East Afric. Agric. Journ. XVII : 2.
Darling, H. S. (1947), Ann. Rep. Dept. Agric. Uganda, 1945–46, Pt. II.
Weindling, R. (1948), U.S. Dept. Agric. Tech. Bull. 956.
Wickens, G. M. (1942), E.C.G.C. Reps. Expt. Stns., 1940–41.
Cochran, W. G., and Cox, G. M. (1950), " Experimental Designs," p. 408.

Received June, 1951.

[*Report of the Section of Botany and Pathology, Department of Agriculture, 1950–51, included by courtesy of the Uganda Government.*]

UGANDA

THE CONTROL OF BLACKARM DISEASE IN COTTON

BY

J. D. JAMESON AND D. G. THOMAS

It has been mentioned in previous reports that a new investigation had been started at Serere on the control of blackarm disease in cotton. This report is an account of work done in the first two seasons, with the assistance of Mr. W. T. Cowan of Messrs. Plant Protection Ltd. in 1949–50, and of Mr. J. M. Pottie of Messrs. Imperial Chemical Industries Limited in 1950–51. Mr. Pottie worked under the general direction of Mr. R. V. Tipler of Hawthorndale Laboratories, who also visited Uganda from time to time. We take this opportunity to record our very sincere appreciation of the collaboration we have received from these two associated firms.

Mr. D. L. Downie, Botanist, assisted with the survey work during the absence of the junior author on leave, and we have also been assisted by Mr. J. G. Wilson, Agricultural Assistant (pathology) and Mr. J. P. M. Batten, Agricultural Assistant (cotton seed distribution). Mr. A. Kamya, Assistant Agricultural Officer, superintended the field work at Serere.

Most of the work was done at Serere Experiment Station in Teso district, and was directed towards the improvement of the cotton crop in Teso in the first instance.

Seed Infection.

Hansford (1934)* produced evidence in support of the view that a seed is rarely infected with blackarm (*Xanthomonas malvacearum*) internally, but that something of the order of one seed in ten may be infected externally in Uganda. The geographical distribution of infection across the north-eastern side of the country appears to be (in descending order of infection) Mbale, Busoga, Teso, South Lango, North Lango.

Serere Variety Trials : blackarm lesions per plant.

	1940–41	1941–42	1942–43	*Mean.*
Seed from :				
North Lango	1·67	1·80	0·87	1·45
South Lango	2·35	2·36	1·22	1·98
Teso	1·73	2·85	1·85	2·14
Busoga	2·30	3·05	1·96	2·45
Mbale	2·13	3·55	2·86	2·85
Significant Difference	—	—	—	0·75

* Hansford, C. G., 1934, E.C.G.C. 2nd Conference on Cotton Growing Problems, p. 184.

This distribution is not readily explained, but there is some suggestion that seed infection is heaviest where the time of planting and the distribution of rainfall are such that green bolls are likely to get infected without aborting. It does not follow that the areas where seed infection is heaviest are areas where blackarm does most damage, because the conditions may be right for seed infection, and wrong for epidemic spread in the growing crop. Conversely, in other areas moderate seed infection may be the start of severe epidemic spread. Either way however there is much to be said for starting with the cleanest possible seed. Subject to confirmation, it would seem that source of seed may be an important consideration in any scheme for the multiplication and distribution of seed for planting.

Some Factors Influencing Infection.

Preliminary experiments were begun in 1948–49 (and continued in the two subsequent seasons) to explore certain aspects of seed infection which might have a bearing on our variety testing programme, and on the seed dressing programme which it was proposed to resume after a lapse of 14 years. These experiments established the following points :

(*a*) Mechanical delinting of the seed increases the proportion of infected plants in the resulting population. One lot of delinted seed suffered a loss of over 90 per cent. at germination associated with bacterial infection. Both tendencies are fully corrected by seed dressing. Nevertheless they are contra-indications, and influenced us to change over from the tunnel type of seed dressing machine, which will take only delinted seed, to the batch mixing type of machine, which will handle any seed.

(*b*) Soaking the seed in water increases the proportion of infected plants. This effect is more pronounced when the seed is dried again before planting. These tendencies are relevant to methods of inoculating seed, and by themselves they are partly effective in standardizing seed for variety trials.

(*c*) Acid delinting of the seed reduces the proportion of infected plants, but only to a certain minimum. This suggests that internal infection may be more prevalent in certain seasons at Serere than it was in the seed with which Hansford worked. Seed dressings are more effective, because they operate at the time of emergence, whether or not they operate at the time of application.

(*d*) Inoculation of the seed with a suspension of infected leaves made by the method described by Knight and Clouston* is no more effective in conferring infection than soaking in plain water. The most effective method of standardizing seed for variety trials so far found is to sterilise the seed in mercuric chloride, inoculate it in a suspension of *X. malvacearum* made by the method described by Weindling,† and dry it before

* KNIGHT, R. L. and CLOUSTON, T. W. (1939). J. Genet., 38, 133.
† WEINDLING, R. (1948). U.S.D.A. Bull. 956.

planting. When making comparisons between varieties, however, it is possible for inoculation to impair seedling emergence in certain varieties to such an extent that the eventual plant population exhibits less infection. There is then a positive correlation between plant population and infection.

(*e*) Exposing seed to sunlight reduces infection in certain circumstances, but there is no evidence that this simple treatment could rival seed dressing in effectiveness.

(*f*) There are several indications that the effectiveness of these various treatments, whether they be designed to increase infection or to reduce it, is intensified by a period of storage between treatment and planting.

Seed Dressing.

Influence of Trash.

It was feared that infection from trash in the soil might upset the benefits to be gained from seed dressing. Preliminary tests showed that trash gathered after the 1948–49 season was still infective in November 1949, that is five months after the next crop had been planted.

In each season a large experiment was planted on freshly opened land, and half the plots were strewn with trash from the previous season's crop. This comparison was combined with five other treatments, a control and four seed dressings:

Main Stem Lesion: % of population.

	1949–50		1950–51	
	Control.	*Trash.*	*Control.*	*Trash.*
Control	50·3	60·0	8·5	9·5
BHC (6% gamma-isomer) ...	37·0	38·0	3·2	7·2
Agrosan GN5 (5% organo-Hg.)	17·7	19·3	1·7	2·5
BHC and Agrosan GN5 ...	12·7	22·0	0·7	5·0
R1489 × 32 (5% organo-Hg.) ...	10·3	16·7	0·5	3·3

In the first season, with high infection, the effect of trash was just not significant. In the second season, with low infection, it was. But these figures may not show the real status of trash clearly. In the control plots in the first season 50 plants in every 100 were infected from the seed, and 50 were not. Trash raised the number of infected plants from 50 to 60, by infecting 10 clean plants. Therefore we must assume that trash re-infected 10 other plants, in the 50 that were already infected from the seed, because a re-infection would not be detected by the counts. We ought therefore to ascribe an infection rate of 20 per cent. to trash in the first season. After treatment with R1489 (10 per cent. infection), trash should have infected two plants a second time, and 18 new plants, bringing the total to 28 per cent. The infection observed was much less than this. Therefore there is some reason to suppose that a seed dressing affords protection for a certain distance round each germinating seedling, and so reduces the infection from trash also.

In the second season the infection rates were too low to be informative, although the effect of trash was relatively more marked after seed treatment.

Preliminary Sorting Tests.

Mr. Cowan and Mr. Pottie tested a large number of compounds in the laboratory, and on a small scale in the field, before each planting season began. The object of these tests was to exclude compounds with phytotoxic effects, and to single out from the remainder those with the strongest bactericidal properties. This was a necessary piece of preliminary routine. Its principal result was to show that dry dressings and short wet treatments (2 per cent. v/w) did not produce any phytotoxic effects, whereas steeps were liable to do so. There is no disadvantage in this, as steeps would not be convenient in practice.

Preliminary Field Trials.

A trial was planted in each season to carry the sorting process a stage further.

Main Stem Lesion : % of population.

	1949–50	1950–51
Control	35·7	11·9
BHC (6% gamma-isomer)	14·7	—
Agrosan GN5 (5% organo-Hg.)	8·5	—
BHC and Agrosan GN5	4·8	—
R1489 × 32 (5% organo-Hg)	5·0	0·5
R1038 × 27 (3·8% organo-Hg.)	0·3	—
R1573 × 3 (5·6% inorganic-Hg.)	7·8	—
Agrosan GN6 (6% organo-Hg.)	—	1·3
Perenox (cuprous oxide 50% Cu.)	11·0	—
Perenox C (cuprous oxide 66% Cu.) ...	—	1·5
G1401 PI × 1 (50% Cu.)	—	1·2
R3144 P2 S4 } (non-metallic organic	—	1·8
R3067 × 1 } compounds)	—	1·8
R3148 × 1 }	—	0·8
Significant Difference	4·9	1·8

The mercury compounds were very efficient, with R1038 as the highest standard attained so far (but too dangerous to be placed in unskilled hands). The copper compounds were also efficient, and safer to handle.

Main Field Trials.

An experiment with large plots and sunnhemp barriers between plots was planted in each season to follow the effects of seed dressing in more detail. The data on infection have already been quoted when considering the influence of trash. An insecticide (with and without mercury) was included as a seed dressing in the preliminary and main field trials, because it was felt that terrestial insects might play some part in the dissemination of infection amongst seedlings. Its inclusion appears to have been justified. In each instance it has brought about a partial, but appreciable, control of infection. The gamma-isomer of benzene hexachloride has no bactericidal properties, a fact which was checked at the Hawthorndale Laboratories of Messrs. Imperial Chemical Industries Ltd., so it is likely that insects do disseminate *X. malvacearum* amongst cotton seedlings.

Effect of Seed Dressing on Yield.

When this work started it was said that it would not be possible to measure the effect of seed dressing on yield reliably in formal replicated experiments at Serere, for two reasons :

(*a*) The essence of a seed dressing programme, if successful, was to clean up the cotton crop over large areas, a process which might well be progressive from year to year. A formal replicated experiment might not measure the effect on yield reliably, even for one year, because the untreated plots in such an experiment might spread their infection to the treated plots.

(*b*) The infestation of insects like *Lygus vosseleri* is almost always much heavier on Serere experiment farm than it is in peasant cultivation. Consequently, on Serere farm, the effect of controlling blackarm might be masked by the effect of heavy *Lygus* attack.

The situation appeared to justify the use of information obtained by less orthodox methods. For example in the first season three variety trials were planted side by side. The seed for the two outer ones was dressed, and the seed for the middle one was not. The standard variety gave almost identical yields in the two outer trials, and its yield in the middle one was frankly compared without replication :

	Main Stem Lesion: (% of population).	*Yield: (lb. per acre).*
Perenox	11·0	1,182
Untreated	52·8	1,003
Perenox	14·3	1,184

Another device was employed in the variety trials of the second season. Two Latin squares were planted side by side, and the seed for one of them was dressed with R1038. The sequence of column totals was fixed by regression, and the response to seed dressing was estimated from the break in this sequence between the two squares.

To meet the second difficulty certain trials received an over-all foliage spray of an insecticide, so that *Lygus vosseleri* was not allowed to become a limiting factor.

Yield Response.

Despite the difficulties it is very important to have some estimate of the magnitude of the yield response after seed dressing, otherwise no assurance can be given that seed dressing is economic. Even estimates from trials where replication is not available are of value, if a number of them point towards a consistent conclusion. In various ways it has been possible to arrive at a figure for yield response from

TABLE 1.
YIELD RESPONSE TO SEED DRESSING.

Experiment.	*Plots.*	*Method.*	*Seed.*	*Insecticide.*	*Seed Dressing.*	*Yield Level (control, lb./acre).*	*Yield Response (treatment, % of control).*
1949–50.							
Main Field Trial ...	large	analysis of variance	BP52, delinted	none	Agrosan GN5	586	105
Preliminary Field Trial	small	analysis of variance	BP52, delinted	none	Agrosan GN5	551	103
Variety Trials, 1, 2, 3.	blocks	sandwich	S47, natural	DDT	Perenox	1,003	118
1950–51.							
Main Field Trial ...	large	analysis of variance	N17, delinted	BHC	Agrosan GN5	564	114
Preliminary Field Trial.	small	analysis of variance	N17, delinted	none	Agrosan GN6	512	100
				BHC	Agrosan GN6	upset by American bollworm.	
				DDT	Agrosan GN6	993	106
Variety Trials, 1, 2	blocks	secular break	S47, natural	DDT	R1038	1,187	119
Kumi Variety Trial	blocks	straight comparison	S47, natural	none	Perenox	748	107

all the trials carried through to harvest. Details are presented in Table 1. To follow up the chain of reasoning these responses may be grouped as follows :

Yield of Plots Sown with Dressed Seed as Percentage of Control.

	Small Plots.	*Large Plots.*	*Blocks.*
No insecticide	103 100	105	107
Over-all insecticide	106	114	118 119

This method is crude from necessity. But it is remarkable that the responses make up such a consistent pattern. The larger the treated area the better the response. And the response is also greater where an insecticide has been applied to prevent any serious build up of *Lygus*. (Note : the response is to seed dressing in the presence of insecticidal protection ; it is not the response to insecticidal protection itself.)

From the point of view of peasant cultivation it would be logical to extrapolate beyond the right hand column, although we have no estimate of the extra benefit to be gained from seed dressing on a district wide scale.

It should be carefully noted that these experiments consider the response in one season only, and contain no progressive effect. In section B of this report it will be seen that seed dressing before planting leads to a cleaner crop, and cleaner seed at harvest. When this seed is planted again, even without dressing, the yield response from the second crop is great. Consequently, the data from these experiments may be a considerable underestimate of the eventual progressive effect.

Bulk Scale Test in Teso.

Mr. Hansford's work on seed dressing came to an end in 1934, because the mercury compounds which he had tested were too dangerous to be placed in unskilled hands. Towards the end of the 1949–50 season it was known that we had found a safe and effective dressing in Perenox (cuprous oxide), and because of the necessary limitation of small scale trials at Serere it was decided to make a bulk scale test in Teso district in 1950–51.

This decision coincided with the issue of seed of the new variety S47 from the Segregated Area to the rest of Teso district. Some 800 tons of this seed were delinted by Messrs. The Liverpool Uganda Company at their Agu and Bugondo ginneries, and the department supplied a Robinson seed dressing machine at each place to dress the seed with Perenox after delinting. There was not time to deal with the whole seed supply, and the actual distribution was as follows :

South Teso Zone : seed delinted and dressed.

North Teso Zone (including Usuku) : natural seed.

Segregated Areas : seed delinted and dressed.

Blackarm Survey.

In September, 1950, Mr. Downie surveyed the crop along two transects, one from Lira to Mbale, and the other from Nariam to Bugondo.

Area.	*Seed.*	*Plant Population. % of population intended.*	*Main Stem Lesion. % of population.*	*Lygus. Leaf damage index.*
Lango	N17 natural	91	31·7	1·85
N. Teso	S47 natural	82	37·4	1·30
Seg. Area	S47 dressed	88	14·6	1·90
S. Teso	S47 dressed	87	20·7	2·40
Bukedea	BP52 natural	90	41·5	2·70

Note.—*Lygus* leaf damage index was an arbitrary assessment, and not the index used by the Section of Entomology. The data presented are arithmetic means of 20 samples in each area.

Germination was sufficient everywhere. S47 had a lower germination than the other varieties, and within S47 the dressed seed germinated better than the natural seed. The data presented show the proportion of stands established in the stand intended, and not the absolute plant population. In point of fact North Teso had the best absolute plant population because the stand intended by the peasant when he planted was nearest the optimum.

Main stem infections were fewer in areas planted with dressed seed. This effect was still clearly apparent to the eye when the senior author toured the district two months later.

The observations on *Lygus* were incidental, but they are interesting because they are believed to be the first numerical record confirming the general observation that *Lygus* is less prevalent on cotton in North Teso. They also confirmed the general observation that July sowings are less attacked than June sowings.

Lygus and blackarm were quite strongly associated in Lango (probability less than 0·01), but not elsewhere. There was also a suspicion in South Teso that the closer populations were more heavily attacked by *Lygus*, and the senior author's observations in November tended to confirm this. There was everywhere a suspicion that the closer populations were more heavily attacked by blackarm, and that blackarm was a sequel to good germination (c.f. the simultaneous reduction of germination and blackarm after inoculation discussed above).

The Cotton Crop in Teso.

Characteristics of the Crop in the Past.

The crop statistics for the 27 seasons from 1923–24 to 1949–50, in bales of all grades, disclose the following characteristics :

General Mean	19,175
Standard Deviation	7,965
Previous Highest	32,201 in 1940–41
Upper Fiducial Limits	35,551 by chance once in 40 years 38,920 by chance once in 100 years

The crops during the past 27 years, though very irregular, show no evidence of a significant trend, either upwards or downwards. Nor have the last two crops (22,545 in 1948–49 and 14,877 in 1949–50) given any evidence of a recent upward turn.

Characteristics of the 1950–51 *Crop.*

Weather Factor : 88 per cent. (based on rainfall in February, August and October).
Planting Time : rather later than average.

	Estimate of Acreage.	*Crop in Bales (estimated).*
South Teso	46,856	14,322 (15,696 in 1930–31).
North Teso : Usuku	11,706	3,977 } (11,584 in 1936–37).
Rest	39,770	8,578 }
Segregated Areas	27,707	10,417 (10,932 in 1940–41).
	126,039 (about average)	37,294 (32,201 in 1940–41).

This crop exceeds the previous record by 5,000 bales, and lies outside the fiducial limit for 40 years. The acreage and planting time were not exceptional, and the weather factor was below normal. The crops in Lango and Mbale, and in the Protectorate as a whole, were not exceptional. A comparison between the 1950–51 and 1949–50 crops in Teso and adjoining districts is of particular interest.

	1950–51 *Crop as % of* 1949–50 *Crop.*
South Lango: unchanged	121 } = 126
North Mbale: unchanged	131 }
North Teso: new variety, no dressing	219
Segregated Area: same seed, dressed	228
South Teso: new variety, dressed...	307

There was no change in either seed supply or seed treatment in South Lango or North Mbale, so the ratio between their 1950–51 and 1949–50 crops may be taken as an index of the effect of season on crop size. Correcting then for the seasonal effect, the effect of new variety and seed dressing may be estimated separately as follows :

$$\text{New variety effect} = \tfrac{1}{2}\left(\frac{(219 + 307 - 126 - 228)}{126}\right) = +68\%$$

$$\text{Seed dressing effect} = \tfrac{1}{2}\left(\frac{(228 + 307 - 126 - 219)}{126}\right) = +75\%$$

These effects are very much larger than those predicted by the variety trials and seed dressing trials respectively.

Costs.

Very roughly the cost of bagging, handling and transporting the new seed was £3 per ton, and the cost of seed dressing another £3 per ton. At 80 acres to the ton this works out at a charge of Shs. 1·50 an acre. The total cost of all operations was therefore :

New Variety	1,600 tons at £3	£4,800
Seed Dressing	800 tons at £3	2,400
		£7,200

The excess crop was 18,119 bales of 400 lb. each. This was sold at 44 pence per pound, so that the gross return was well over £1,000,000.

COTTON VARIETY TESTING AND SEED DISTRIBUTION.

BY

J. D. JAMESON AND D. G. THOMAS

VARIETY BP 52.

History.

Mr. A. L. Stephens selected the original plant, B42, from a plot of Nyasaland Upland 3/5 at Bukalasa in the 1928–29 season. Mr. G. W. Nye selected single plants from the first, second and third generations and founded B42/12/14/13 as Bukalasa Pedigree No. 52 (i.e. BP52) in the 1933–34 season. BP52 was not resistant to blackarm. There have been three releases of BP52 to general cultivation :

(*a*) From Bukalasa, grown on Kawanda Seed Farm in 1938 and 1939.

(*b*) From Kawanda, grown on Kawanda Seed Farm in 1942 and 1943.

(*c*) From Serere, grown on Kawanda Seed Farm in 1944, 1945 and 1946.

All Buganda has now nominally received the seed derived from Serere.

In 1943 Mr. C. G. Hansford planted a plot of BP52 bulk seed at Kawanda amounting to some 3,000 plants, from which he selected about 1,100 initially in the field. Of these 876 were allowed to continue to harvest, and the senior author separated these in the laboratory into three groups :

A. A group of 52 plants with quality well above average, later reduced to 23 high yielding plants, of which two were taken out as single plant selections and numbered KP45 and KP46.

B. A group of 535 plants with good average quality, later reduced to 150 high yielding plants.

C. 289 discards of low quality.

The B group was grown at Kawanda as 150 progeny rows in 1944–45, and one of these was rejected as off-type. The remaining 149 progenies were bulked as BP52B. This type therefore amounts to a purification for quality, combined with strong selection pressure for yield, made in a single season. It has yielded 6 per cent. more seed cotton than its contemporary bulk seed, and its ginning percentage is higher by 0·5 per cent. or more. It has also spun six counts better than its contemporary bulk. It contains a proportion of plants resistant to blackarm, which must have picked up their resistance by hybridization during their five years or so of bulk cultivation.

A transference of blackarm resistance from B181 to BP52 made by Mr. Nye was carried by Mr. Hansford to the stage of a third back-cross, which was numbered BC66. This was multiplied up by the senior author at Kawanda in 1944. The benefit conferred by this resistance in a rain-fed crop is limited. The yield of seed cotton from BC66 is somewhat shy, although the ginning percentage is good.

Further breeding work passed under the control of the Empire Cotton Growing Corporation in 1946, and the work was moved from Kawanda to Namulonge in 1949. They have sent us four strains for test :

(*a*) 1MB and 2MB, which are modal bulks, and represent further stages of purification, without the exercise of selection pressure.

(*b*) C(48)4 and C(48)12, which are single plant selections, representing advances in the directions of quality and ginning percentage respectively.

Variety Testing.

District Variety Trials.—By courtesy of the Empire Cotton Growing Corporation an additional trial site was made available in 1949 at their new station at Namulonge. A new site was also opened at Namyoya in 1949 to replace the old one at Nakifuma, but both these sites were used in parallel for one season for comparison. In Masaka district the temporary site at Kisagazi was abandoned in 1949 in favour of one at the new farm at Kamenyamigo. As no advance on the standard

can be recorded the results from the series of fourteen trials in the 1949–50 season may be summarized briefly as follows :

	BP52B	BP52 1MB	BC66	B181	S47
Blackarm, % of population... ...	17·2	17·6	13·0	19·1	15·6
Total Seed Cotton, lb./acre	897·0	902·0	851·0	881·0	891·0
Ginning %	32·9	32·2	32·4	32·5	32·0
Clean Lint, lb./acre	268·0	262·0	253·0	260·0	261·0

The ginning percentages appear very high, but a straight run of over 50,000 lb. of seed cotton of the variety BC66 gave an out-turn of 32·2 per cent. in Kawanda ginnery.

In the 1950–51 season there was no considerable advance on the standard variety, so the results may be summarized briefly as follows :

	BP52 Nyendo bulk.	BP52 2MB.	C(48)4.	C(48)12.	S47.
Blackarm, % of population... ...	13·7	10·2	7·9	5·6	14·5
Total Seed Cotton lb./acre	1,123·0	1,069·0	1,079·0	1,113·0	1,057·0
Ginning %	32·7	33·0	31·9	33·8	33·0
Clean Lint, lb./acre	345·0	334·0	320·0	358·0	333·0

Seed Distribution.

Buganda and Western Province.—For a number of years seed purity has been estimated by counting in a sample the number of black seeds remaining from the old variety. Small lots of fuzzy and black seeds have been grown each year, and of course the value of this index is steadily deteriorating as hybridization takes place between the two types. The index is still of some value, but only as an index, and not as an exact measure.

In the 1948–49 season the index of purity for BP52 bulk stood at only 70 per cent. An intensive effort in the next two seasons, which cost the department about £20,000, raised the index to 85 per cent. in 1949–50, and to 90 per cent. in 1950–51. The seed movements which achieved this were as follows :

1949.		1950.	
Bugerere	to East Kyagwe East Bulemezi Masaka	Bugerere	to East Kyagwe North Kyagwe Singo Toro
East Kyagwe	to Central Bulemezi Kyadondo Entebbe	East Kyagwe	to South Kyagwe North Kyagwe Kyadondo Singo Mubende
South Kyagwe	to West Bulemezi	Bulemezi	internal redistribution
West Nile	to Singo Mubende Toro	Masaka	internal redistribution

The variety BC66 was sent to South Bunyoro in 1948 and multiplied there for two years, enabling the whole of Bunyoro to be supplied with it in the 1950–51 season. This seed is regarded as a strategic reserve.

It is also sound policy to grow big bulks of strains which are resistant to blackarm wherever possible. Even if they give only temporary satisfaction, they spread the genes for resistance over a wide area, and provide scope for natural selection to make further advances.

It has recently been decided to proceed with the multiplication of BP52B, by growing it on Kawanda Seed Farm in 1951.

Variety S47

History.

Mr. Stephens selected the original plant B37 from the old mixed Sunflower-Allen crop growing in Bulemezi in the 1928–29 season. Mr. Nye selected single plants from the first and second generations, and founded B37/5/18 as BP50 in the 1932–33 season. BP50 was multiplied at Bukalasa with the intention of growing it in Buganda. But the 1935–36 crop of 18 acres displayed such marked susceptibility to *Verticillium* wilt disease that the variety was discarded in favour of BP52. It contained a proportion of plants which were susceptible to blackarm also.

About this time BP50 was sent to Serere for trial there. Wilt disease seldom occurs at Serere. By 1940 derivatives of BP50 had out-yielded all the Serere varieties, but the blackarm difficulty remained.

In 1942 the senior author, assisted by Mr. Stephens, employed Knight's* spraying technique to sort out the blackarm resistant plants in the variety at Serere, and the sorting was done according to very rigorous standards. All the reselections from BP50 were susceptible and were discarded. But a stock of the original bulk seed, which had been kept going from year to year, yielded a fair proportion of resistant plants. Some of these may have acquired their resistance by chance hybridization during the period of bulk cultivation. But it was believed that the majority derived their resistance from the original stock, because the possibility of genetic segregation for blackarm resistance had been discussed at Bukalasa in 1935 in connection with BP50. In the 1943–44 season blackarm resistant progenies, homozygous for at least one gene, were fixed. These progenies were re-tested in 1944–45, and after exercising some selection for yield, 22 of them were bulked for multiplication in 1945 under the accession number S5302. After multiplication at Serere the seed was released to the first Segregated Area in 1947, for which reason it was subsequently named S47.

Breeding.

Selection.—S47 has a very narrow range of variability, and the scope for further selection is more limited than in any other material yet handled in Uganda. A constant watch has been kept for plants which might be more resistant to blackarm than the parent bulk. In this we have not yet been obviously successful, and a proportion of the selections made have proved to be less resistant than S47 itself.

* KNIGHT, R. L. and CLOUSTON, T. W. (1939), J. Genet., 38, 133.

To give this work the best chance of success breeding has been carried out at Bukalasa, Ngetta and Serere. The selections made have been handed round and tested at all three places. Bukalasa has proved to be the most efficient centre for discriminating between new material, when no artificial control is exercised, because the incidence of pests and diseases there is not extreme.

One of the strong points about S47 is that it yields well over a wide range of places, seasons and planting times. A lot of cotton is planted later than one might wish, and every effort should be made to plant as much as possible at the right time. Nevertheless :

(*a*) Late cotton fits into the agricultural system better in a good many years. The food supply must be raised in the first rains of the year. Therefore a good deal of land is often not available for cotton until after the proper time for planting has passed.

(*b*) Late cotton is cheaper to grow, and may show a better profit, if the yield is not too much reduced. This is because the incidence of pests and diseases is less, the plants are not so untidy, and the crop flushes in a more concentrated period.

No one would advocate unnecessary delay in planting. Our contention is that cotton planted at the right time will look after itself, and that the cotton which is planted late should be catered for. With the intention of reducing the crop risk taken by those who, for one reason or another, plant late, breeding plots and variety trials have been planted later in recent years.

Hybridization.—S47 is susceptible to *Verticillium* wilt disease. Although somewhat resistant to blackarm, it is not as resistant as B181, KP28 or S4108. Any improvement in the resistance of S47 to blackarm would be a great advantage.

If S47 were resistant to wilt it could be grown over a wider range of country. An attempt to transfer resistance from B181 and KP28 to S47 has been in progress for some time. The sorting process presents difficulties, but a back-cross population has been developed which probably contains a certain amount of resistance.

The same material should also serve to bring the resistance of B181 and KP28 to blackarm into S47. It has been sorted at Serere for three years by very rigorous standards, and a number of progenies with improved resistance have been fixed.

A first back-cross has been made using S4108 as donor parent, as this variety has achieved remarkable yields in the district trials (See under " Other Varieties," below.)

Variety Testing.

Primary Variety Trials.—Although the first order trials at Bukalasa, Ngetta and Serere in 1949–50 and 1950–51 were mostly planted late, they maintained, with one exception, a very high yield level. At Serere the trials were protected from *Lygus* with an insecticidal spray in both seasons, and the seed was dressed with Perenox

before planting in 1949–50. The trial at Ngetta in 1950–51 was devastated by *Lygus* and American bollworm (*Heliothis obsoleta*). It is interesting that two of the leading varieties maintained their place in this trial, but the conditions were too extreme to provide any real information about the behaviour of the varieties at a low yield level.

TOTAL SEED COTTON : lb. per acre.

	1949–50.				1950–51.			
	Bukalasa.	*Ngetta.*	*Serere.*	*Mean.*	*Bukalasa.*	*Ngetta.*	*Serere.*	*Bukalasa and Serere.*
Sowing Date.	*24 Aug.*	*29 June.*	*5 July.*		*19 July.*	*14 July.*	*27 June.*	
S4312	1,159	944	1,267	1,123	—	—	—	—
S4322	1,229	998	1,168	1,132	—	—	—	—
S47	1,169	1,084	1,181	1,145	1,512	129	1,072	1,292
S6317	1,302	838	1,178	1,106	1,350	74	1,118	1,234
S6333	1,309	954	1,305	1,189	—	—	—	—
S6336	1,399	1,064	1,219	1,227	1,433	118	1,089	1,261
S6354	1,258	998	1,363	1,206	1,359	109	1,189	1,274
S6358	1,212	1,002	1,320	1,178	1,500	138	1,192	1,346
B9307	—	—	—	—	1,774	155	1,246	1,510
B9312	—	—	—	—	1,437	116	1,210	1,324
B9325	—	—	—	—	1,636	115	992	1,314
B9330	—	—	—	—	1,549	107	1,204	1,377
B9358	—	—	—	—	1,625	93	1,141	1,383
S9385	—	—	—	—	1,477	97	1,093	1,285
S9388	—	—	—	—	1,381	141	1,016	1,199
S9395	—	—	—	—	1,577	154	1,185	1,381
Mean	1,255	985	1,250	—	1,508	119	1,134	—
Significant Difference	133	none	none	—	190	50	none	—

S6317 has lint of high quality, but is susceptible to blackarm, so that its yield is unreliable. The most reliable yielders appear to be S6358, B9307 and S9395. Three new bulks have been made up :

SR031 comprising S6317, S6336, S6354, S6358.

BK032 comprising B9307, B9312, B9325, B9330, B9358.

SR131 comprising S6358, B9307, S9395.

District Variety Trials.—The district trials in 1949–50 were heavily infected with blackarm at the primary stage, and this infection had a strong influence on the eventual yields. Since the yields depended so largely on the amount of infection which each lot of seed happened to carry, they provided little real information, and are only summarized briefly.

TOTAL SEED COTTON : lb. per acre.

	N17	*BP52*	*KP28*	*S4101*	*S4108*	*S47*	*S6358*
11 centres in East Acholi, Lango, Teso and Busoga ...	870	—	—	944	1,079	914	960
6 centres in West Nile, West Acholi and Mbale	—	658	—	698	825	673	706
2 centres in North Teso ...	—	—	753	637	725	676	695

The following table summarizes the yields for the 1950–51 season.

	N17	*BP52*	*S47*	*S6317*	*S6336*	*S6354*	*S6358*
9 centres in East Acholi, Lango and Busoga	610	—	664	608	—	609	615
5 centres in West Acholi and Mbale	—	565	645	598	—	605	622
5 centres in West Nile and Teso	—	—	1,022	851	880	870	963

In the 1950–51 season seed of S47 (which is resistant to blackarm) was taken from the main farm at Serere. This farm was planted with dressed seed in 1949, and sustained only a light blackarm attack. Consequently the seed planted in the trials was comparatively free of blackarm infection, even though it was not itself dressed. The seed of S6317 (which is susceptible to blackarm) came from an untreated field, and carried a fairly heavy blackarm infection. The comparison between the two varieties is therefore confounded with the effect of blackarm, and a study of the yields of S47 in terms of S6317 is instructive. The relevant data are available for 17 of the 19 trials quoted above.

Number of Trials.	*Frequency of Cotton in Rotation.*	*S47 % Blackarm.*	*Lygus Attack.*	*Yield of S47 as % of S6317.*
5	1 year in 6	6·6	light	126
6	1 year in 6	5·4	moderate to severe	105
6	1 year in 2 or cotton after cotton	22·0	light to severe	102

Starting with unusually clean seed, the influence of rotation on blackarm infection was marked, and probably depended upon the presence or absence of trash. The benefit of low blackarm infection was only realised as yield when *Lygus* attack remained light.

Testing Under Local Conditions.—In the three seasons from 1946–47 to 1948–49 there were ten variety trials within a radius of 40 miles from Serere that could be divided into five pairs, one member of each pair being planted well before the middle of June, and the other member planted after that date. The mean lint yields of N17 and S47 from these trials were as follows :

Lint: lb. per acre.

	May and Early June.	*Late June and July.*
N17	132	144
S47	118	194

The variety by sowing date interaction in favour of S47 in the later group is significant (probability less than 0·01). These figures are so striking that they merit more detailed examination. The yields of

N17 and S47 in these ten trials are plotted against sowing date in Figure 1. In the five earlier sown trials the difference between varieties

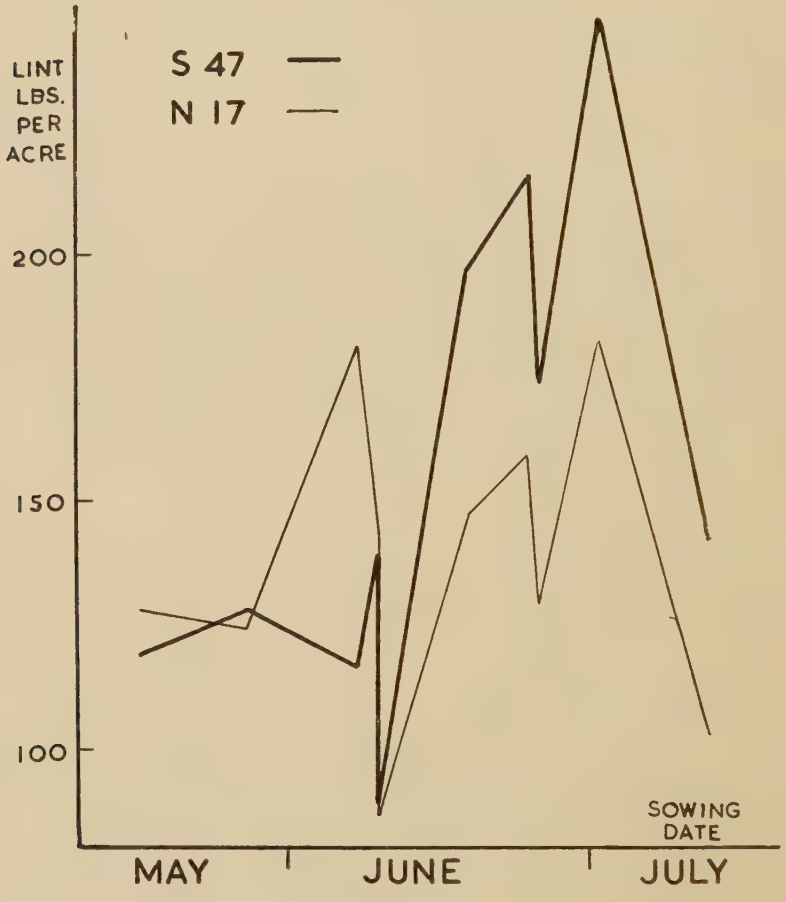


FIGURE 1.

Yields of strains S47 and N17 plotted against sowing date in ten trials.

is negligible in four cases, and in favour of N17 in the remaining one. In the five later sown trials the yields of N17 are not greatly different, but the yields of S47, at least up to the first week in July, are of an altogether higher order. The bulk of the Teso crop is planted between mid-June and mid-July, which is the time at which the greatest advantage is to be expected from S47.

Seed Distribution.

Eastern and Northern Provinces.—The distribution of S47 has proceeded as follows :

	Teso.		*West Nile.*
1947–48 Serere	to Mulondo		
1948–49 Mulondo	to Kadunguru;	and	to Obongi
1949–50 Kadunguru	to Seg. Area	Obongi	to East Madi
1950–51 Seg. Area	to North and South Teso (126,000 acres)	East Madi	to West Nile-Madi (58,000 acres)

The seed is being sent in 1951 to Acholi, Lango and Mbale, completing the whole of the Eastern and Northern Provinces, except Busoga. It is also being sent to Nyanza No. 1 area in Kenya, which marches with Mbale district.

Other Varieties.

B181 and KP28.

For the sake of their resistance to blackarm these varieties were increased in North Teso as a temporary measure, and the whole zone was supplied in 1949–50 for one season only. Their resistance to blackarm was useful, but they were slow maturing and intolerant of *Lygus* attack. They are retained now only as donors of wilt resistance and blackarm resistance.

S4108

District Variety Trials.—The variety S4108, an off-type selection from N17 of unknown male parentage, has a remarkable record in the district trials. In the four seasons from 1946–47 to 1949–50 the lint yields of S4108 expressed as a percentage of S47 at the four variety trial centres in Teso were as follows :

	Kuju.	*Katakwe.*	*Serere.*	*Kumi.*
1946–47... ...	136	—	141	121
1947–48... ...	131	—	115	137
1948–49... ...	—	—	139	158
1949–50... ...	111	133	147	124
General Mean: 133%				

The final decision to proceed with the multiplication and distribution of S47 was taken in February 1948. It was a difficult decision, and S47 was preferred to S4108 for three reasons :

(*a*) A decision in favour of S4108 would have entailed a delay of four years, owing to the much smaller quantity of seed available.

(*b*) S4108 is a typical untidy plant belonging to the Nyasaland Upland group, and it was felt that S47 would be much easier and cheaper to cultivate. Furthermore it was felt that the average cultivator would pick more from a trim, quick-flushing type like S47, and so realise a bigger advantage than the variety trials indicated. Any future change that did not retain these advantages would now be very unpopular.

(*c*) S4108 is a bare one inch cotton, and would have entailed a major change in the market.

The distribution of S47 has evoked an enthusiasm which appears to have justified the second of these reasons. Nevertheless the very high yield of S4108 demanded further attention.

S4108 is very resistant to blackarm, even after hail. In the face of severe blackarm attack after a hailstorm at Bulopa in 1949–50, it produced much the biggest crop of any variety, and the cotton was much cleaner. For this reason it has been used as donor parent in a transference to S47 (see under " Variety S47," above).

Acknowledgement.

The authors are indebted to Dr. J. B. Hutchinson, C.M.G., F.R.S., of the Empire Cotton Growing Corporation, Namulonge, for criticism and much useful discussion, particularly on the subject of variety by sowing date interaction.

Received March 1952.

TANGANYIKA TERRITORY.

LAKE PROVINCE.

PROGRESS REPORT FOR THE SEASON 1950-51.

BY

J. E. PEAT and J. M. MUNRO.

Cotton, Ukiriguru.

Planting	29th November to 27th January.
Picking	May to September.
Legal Uprooting date	17th September.
Rainfall for the Period 1st October to 30th June ...	33·39 inches.

Meteorology.

The rainfall for the season was satisfactory. A week of good rain at the end of October allowed an early start to be made with land preparation ; November was dry. From early December there was an even distribution until the end of April.

Staff.

Apart from the addition of Mr. R. Smith, who arrived at Ukiriguru on first appointment in September, 1951, the staffing remained as reported last year : Mr. J. E. Peat and Mr. J. M. Munro and three officers of the Agricultural Department, Mr. H. Doggett, Botanist, and Mr. D. C. Randall, Agricultural Assistant, at Ukiriguru, and Mr. G. H. McGavin, Agricultural Assistant, at Lubaga.

Station Development.

The laboratory-office block, ginnery, stores and quarters at Ukiriguru have been completed and are in use. Further land development has been held up by the shortage of labour, and in fact the maintenance work on land and roads throughout the year has been quite insufficient.

General Introduction.

The 1950–51 Season.

Climatically the season was a good one, but cotton planting was generally late to very late, and labour for cultivation was scarce and difficult. For a number of reasons, at planting time, the people of the Province were unsettled. In many areas the returns from hedge-row sisal had been substantial ; figures up to Shs. 10/- per day for a family have been mentioned. In the hands of people not used to it, such money was unsettling. The people, with their simple wants satisfied temporarily, were disinclined to start the labour of hand cultivation for the new season. And to the South of the Province the pattern of field practices seemed to get behind. The previous

season's sorghum crop had been a heavy one ; the people had to complete the movement of their crop, and get the next sorghum crop planted, before they turned to cotton planting.

As was forecast in last season's report, the acreage of timely planted cotton was much below the normal, but fair acreages were planted later in January, in February, and even into March. Yields from the later planted cotton were considerably lower than from the earlier plantings. The Provincial crop of just over 40,000 bales (higher than the early forecasts) must therefore be considered quite reasonable. With timely planting an appreciably larger crop should have resulted.

Uk46 was in cultivation throughout the Province, with the exception of the Shinyanga district (ginning difficulties prevented seed being available in time to cover the whole Province). Uk46 in general bulk cultivation cropped well to the end of the season. This may have contributed in part to the final crop realised. Uk46, in commercial ginning, gave more than the 1·5% increase in ginning percentage over Mz561 which experimental results had indicated.

The Lake Province Cotton Committee, shortly it is hoped to be regularised under the Cotton Lint and Seed Marketing Ordinance, continues active operations. But time is necessary before noticeable practical benefits can be expected to appear as a result of its work. Especially is this so with the mechanisation. Much of this is experimental ; testing equipment and maintenance problems, the reactions of the people to mechanisation, and the effects on their land tenure customs. Most cotton in the Lake Province is grown on ridges in the lighter land areas. After many difficulties, equipment for such ridging, obtained from the United States, should soon be available.

At Ukiriguru, and at Lubaga, the shortages of manual labour have made it a very difficult year indeed. Only the International Harvester tractor and the ridging equipment allowed of sufficient land preparation for a reasonable planting programme. But there were serious delays in weeding ; picking was protracted ; and bird loss was heavy on the bulrush millet before harvesting was possible.

Hill ridged land is difficult to keep clean except by hand labour ; inter-row cultivation is impeded by the big ties. With hand ridging the dry season growth is pulled into the old furrow and the new ridge is then built over it. With mechanical ridge-breaking and building, there are greater dispersal of weeds and, therefore, more insistent problems of weeding through the growing season.

1951–52 *Cotton Planting.*

Hedgerow sisal prices have been lower than a year ago, and in this market there have been disappointments to the peasant. As against this, the cotton price for the new season has been raised from 34 to 50 cents per lb. seed cotton. There have also been good (though for some areas and soil types, excessive) early rains. As a

result a large cotton acreage has been planted satisfactorily early. There is promise, therefore, of a substantially increased crop for the Lake Province this coming season.

The Overseas Food Corporation Areas.

Visits were paid by Mr. Bebbington and Mr. Peat in March and July to the Overseas Food Corporation areas at Urambo, Kongwa and Nachingwea. Experimental plantings of cotton had been made in each region. Especially at Urambo and Kongwa, *Calidea* and *Dysdercus* attack make it unlikely that cotton can be grown successfully. At Nachingwea, in the Southern Province, severe American bollworm loss, followed by *Dysdercus* attack, very much reduced yields. This 1951–52 season the Empire Cotton Growing Corporation are guiding the technical approach to cotton experimentation at Nachingwea, and an Overseas Food Corporation entomologist, Mr. J. B. Ward, has been placed under the technical direction of the Empire Cotton Growing Corporation to this end.

Summary of the Main Experimental Results.

The effect of a three years' "tumbledown" fallow (broken up for the 1948–49 season and therefore in the third year of the cropping cycle) was significantly greater than that of a similar fallow which had been planted with local grasses and legumes.

Responses to three years under resting variants were still evident in experiments in the third, fifth, and seventh years of cropping.

Residual responses from single applications of organic manure have been significant up to the seventh season from application. Responses from superphosphate are recorded at least three seasons after application.

The value is confirmed of applying nitrogen to cotton as a top dressing at flowering time.

Good tied ridges have given small increases in yield, significant in the case of bulrush millet, over poor ridges not tied; the residual benefit of compost has been greater with tied ridges. At Lubaga this year, results from ridged cultivation compared with flat cultivation were inconclusive.

A new seed issue, Uk51, was constituted. The results of yield trials show satisfactory progress with selected material. A hybridising programme has been started to add resistance to bacterial blight to the Ukiriguru strains, and to improve the jassid resistance of some of them.

General Account of the Work for the Season.

Husbandry.

In earlier years there was difficulty in interpreting some of the Ukiriguru husbandry results. The results of this past season help to clarify the picture. (Discussions with Dr. A. H. Bunting, lately Chief

Scientific Officer of the Overseas Food Corporation, and simple preliminary analyses arranged by him, have been much appreciated). It is hoped that shortly a soil chemist, as part of his activities, may be available to follow up aspects of the Ukiriguru husbandry work.

It would appear that phosphate plays a large part in many of the benefits being obtained, and that the availability of nitrogen to the plant under differing treatments is also of high importance. From first simple analyses it seems likely that phosphate is one of the dominant factors in the long continuing responses to organic dressings.

Partly as a result of treatment delays due to shortages of labour, there has been little information from the Lubaga husbandry experiments or from Ukiriguru experiments on " mbuga " treatment ; nor have " mbuga " experiments been possible for this 1951–52 season.

Land Resting.

The four resting crop trials at Ukiriguru, on hill-sand, discussed in earlier reports (Trials 1, 2, 3 and 4) were under bulrush millet ; this past season two were carrying the seventh indicator crop, and two the fifth indicator crop, since the resting crops were dug in. The bulrush millet could not be harvested in time, and there was considerable loss of grain from birds. Weights of heads without grain were used as some measure of the responses. In one of the two trials started in 1941–42 there were significant responses to some of the resting treatments in this, the seventh season after the digging in of the resting variants ; the second trial did not show significant responses. Both the trials started in 1943–44 showed significant responses to treatments dug in five seasons previously. The suggestion made—which of course has to be followed up—is that phosphate may have been made available by these resting treatments.

TABLE 1.

RESTING CROP AND MANURIAL TRIAL.

Ukiriguru—Hill Sand—Trial (6).

6 blocks of 5 plots of $\frac{1}{27 \cdot 2}$ *acres. 5 foot ridges, 2 rows at 18" spacing, 2 plants per hole. Planted 14th December,* 1950.

Three years Resting Cycle 1945–46 *to* 1947–48. *Treatments.*	*Three years Cropping Cycle* 1948–49 *to* 1950–51. *3rd Indicator Crop—Cotton.* *Yield lb. Seed Cotton per acre.*	*Control* = 100.
A. *Continuous cropping* with bulrush millet, undersown with food legumes.		
1. Control, no manure	430 =	100%
2. 3 tons per acre compost in 1945–46, and again in 1948–49. Second year residual response to compost	612	143
3. 400 lb. per acre raw rock phosphate in 1945–46, and 300 lb. per acre single superphosphate in 1948–49. Second year residual response to phosphate	677	158
B. *Resting Treatments.*		
4. 3 years planted grass fallow, undersown *Tephrosia* and *Crotalaria*—grazed	541	126
5. 3 years " tumbledown " fallow—grazed	704	164
Sign. Diff. (P = ·05)	129	30%
S.E.	±45·1	

In Table 1 are given the yields (second residual responses) from a combined resting crop and manurial trial, Trial (6). The second residual responses from compost and from single superphosphate are good; but the interesting response is from the "tumbledown" fallow variant, three seasons away from the breaking up. For the first crop of the cropping cycle, yields on these plots were depressed (see 1949–50 Report, Table 2). In the second year they gave the top yields of the experiment, and similarly this past season. In both seasons the yields from the "tumbledown" fallow plots were significantly greater than those following the planted grass fallow. The planted grass plots gave fair grazing; the cover on the "tumbledown" plots was largely *Tridax repens*. Though both variants were grazed, more would have been removed from the planted grass plots, as the grazing was better; oxen have to be removed at nights to bomas.

In weeding experiments, to be mentioned later, there was, in certain of the delayed weeding plots, a heavy growth of *Tridax repens* which smothered the struggling cotton. Dr. A. H. Bunting on a visit suggested that *Tridax* might be a very efficient obtainer of phosphate, much more so than the crop plants. A sampling in some of the plots showed about 1,000 lb. of air dried *Tridax*, tops and roots, per acre, which on analysis was equivalent in P to a fair dressing of single superphosphate. A following up is essential, but it is possible that at least a part of the "tumbledown" fallow story, which so far has been difficult to interpret, may be in fact largely a phosphate story.

Manuring and Fertilisers.

The substantial benefits from applications of organic manure on Ukiriguru hill-sand have continued. Trial (8), which was manured in the 1944–45 season, still shows most striking residual effects in this the seventh season (see Table 2). (F.Y.M. is made under cover, and compost in open "bomas" where the cattle are herded at night; a higher proportion of stover and crop residues is trampled into the compost.)

TABLE 2.

MANURIAL TRIAL.

Ukiriguru—Hill Sand—Trial (8).

8 blocks of 6 plots of $\frac{1}{17{\cdot}8}$ *acres. Planted 14th December,* 1950. *5 foot ridges, 2 rows at 18" spacing, 2 plants per hole.*

Manurial application made in season 1944–45.	*Seventh year (sixth residual) responses—1950–51: Indicator Crop—Cotton.*	
	Yield lb. Seed Cotton per acre.	*Control = 100%*
Control—unmanured	360 =	100%
F.Y.M.—3 tons per acre	457	127
Compost—3 tons per acre	388	108
F.Y.M.—7 tons per acre	540	150
Compost—7 tons per acre	501	139
Cotton seed ash—1½ tons per acre	530	147
Sign. Diff. (P=·05)	104	29%
S.E.	± 36·2	

The enhanced residual benefits from organic manure as a result of ridge tying are again indicated by the second residual responses in Trial (15), Table 3 (cf. Table 4, 1949–50 report).

TABLE 3.

RIDGING TRIAL.

Ukiriguru—Hill Sand—Trial (15).

2 × 2 × 2 factorial with tie-ridging, height of ridge, and manuring. 4 blocks of 8 plots of $\frac{1}{29{\cdot}0}$ acres. Planted 6th December, 1950. 5 foot ridges, 2 rows at 18" spacing, 2 plants per hole.

Treatment.	*Yield in lb. Seed Cotton per acre 1950–51.*	
	No manure.	*Manured 1948–49 (Compost 5 tons per acre.)*
Not tied—Control	761	995
Tied	730	1103
Sign. Diff. (P = ·05)	122	
S.E.	±41·4	

The results of Trial (9) (Table 4) compared the effects of organic and inorganic manures on hill sand. This trial was started in the 1947–48 season as an NPK trial, with the nitrogen and control plots split into a 3 × 2 factorial arrangement of P and K. The potash gave no response, and the soda phosphate was much less effective than superphosphate has proved to be in later trials.

TABLE 4.

NPD EXPERIMENT.

Ukiriguru—Hill Sand—Trial (9).

Main plots split to give 3 × 2 factorial, testing all combinations of :—

(Main Plots)	n_0, n_1	0, 250 lb. sulphate of ammonia per acre.
(Split Plots)	d_0, d_1	0, 6 tons compost per acre.
	p_0, p_1, p_2	0, 45, 90 lb. triple supers per acre.

6 replications of 12 plots, each $\frac{1}{69{\cdot}7}$ acres. Compost and phosphate applied 6th–8th December, 1950 ; planted 13th December, 1950 ; nitrogen applied 19th–20th March, 1951. 5 foot ridges, 2 rows at 18" spacing, 2 plants per hole.

YEAR OF APPLICATION.

Mean Yields lb. seed cotton per acre (p and d adjusted for stand).

n_0 ... 1116	p_0 ... 1218	d_0 ... 1177
n_1 ... 1510	p_1 ... 1248	d_1 ... 1443
	p_2 ... 1444	
S.E. ... ± 60·0	± 36·2	±29·6

Interactions.

np_2 ... + 32	p_2d ... − 50	nd ... − 13
S.E. ... ± 25·6	± 25·6	± 20·8

Treatment Yields.

	(1)	d	n	nd
p_0	919	1296	1092	1563
p_1	984	1209	1405	1475
p_2	1135	1405	1528	1708
S.E.	p and d treatments ± 72·2			
	n treatments ±160·8			

Adjustment for stand ... ... b = 1·505 ± 0·3290

This season a further manurial treatment was applied ; compost was substituted for potash, and triple superphosphate for soda-phosphate, using the same plot lay-out. The nitrogen and phosphate (p_2) dressings were intended roughly to be equivalent to the amounts applied in the compost treatment.

Composting gave about 400 lb. an acre increase in yield of seed cotton ; sulphate of ammonia added about 200 lb. an acre. There was practically no interaction between them after adjustment for stand.

Triple superphosphate alone, at 90 lb. an acre, gave an increase of 200 lb. an acre, some of which might be attributed to the residual effect of the previous application of soda-phosphate three seasons before. In the presence of nitrogen this P effect is more than doubled but the interaction is not significant. The plots which had the full dressing of all fertilisers yielded 800 lb. an acre more than the control. Yields were adjusted for differences in stand : these were not due to treatments.

TABLE 5.

NPD EXPERIMENT.

Ukiriguru—Hill Sand—Trial (11).

3×3×3 experiment in 6 blocks of 9 plots each of $\frac{1}{48{\cdot}4}$ acres (confounding certain 3-term interactions) testing all combinations of :—

n_0, n_1, n_2	0, 125, 250 lb. sulphate of ammonia per acre.
p_0, p_1, p_2	0, 45, 90 lb. triple supers per acre.
d_0, d_1, d_2	0, 3, 6 tons compost per acre.

Phosphate and compost applied on 6th December, 1949 ; nitrogen applied on 27th February, 1950. Planted on 20th December, 1950. 5 foot ridges, 2 rows at 18" spacing, 2 plants per hole.

FIRST RESIDUAL YEAR.

Mean Yields. lb. Seed Cotton per acre.

n_0 ...	855	p_0 ...	813	d_0 ...	729
n_1 ...	888	p_1 ...	864	d_1 ...	866
n_2 ...	818	p_2 ...	881	d_2 ...	963

Sign. Diff. ... ... 71 S.E. ... ... ±24·4

Interactions.

n_2p_2 ... +14 p_2d_2 ... −45 n_2d_2 ... −9 S.E. ... ±21·1

3×3 table.

	d_0	d_1	d_2
p_0	641	825	974
p_1	754	865	975
p_2	793	908	944

Sign. Diff. ... ... 123 S.E. ... ... ±42·2

TABLE 6.

NPKD EXPERIMENT.

Ukiriguru—Hill Sand—Trial (10).

3×3×3×3 experiment in 9 blocks of 9 plots each of $\frac{1}{48{\cdot}4}$ acres (confounding certain 3- and 4-term interactions) testing all combinations of :—

n_0, n_1, n_2	0, 100, 200 lb. sulphate of ammonia per acre.
p_0, p_1, p_2	0, 100, 200 lb. superphosphate per acre.
k_0 , k_1, k_2	0, 50, 100 lb. sulphate of potash per acre.
d_0, d_1, d_2	0, 5 (dry), 5 (wet), tons compost per acre.

Fertilisers applied 12th November, 1948. Planted on 3rd January, 1951. 5 foot ridges, 2 rows at 18" spacing, 2 plants per hole.

SECOND RESIDUAL YEAR.

Mean Yields. lb. seed cotton per acre.

n_0 ...	1070	p_0 ...	1022	k_0 ...	1060	d_0 ...	933
n_1 ...	1071	p_1 ...	1062	k_1 ...	1052	d_1 ...	1110
n_2 ...	1048	p_2 ...	1100	k_2 ...	1077	d_2 ...	1145

Sign. Diff. ... ... 69 S.E. ... ... ±24·3

Interactions.

n_2p_2 ... −11	n_2k_2 ... +26	n_2d_2 ... +16
p_2d_2 ... −37	k_2d_2 ... + 4	p_2k_2 ... −19

S.E. ... ±22·5

3−3 table.

	d_0	d_1	d_2
p_0	836	1079	1159
p_1	983	1092	1118
p_2	985	1164	1158

Sign. Diff. ... ... 128 S.E. ... ... ±44·9

The main conclusions to be drawn are that phosphate applied at planting, combined with nitrogen top dressed at flowering time, gives results in the year of application greater than those obtained from compost alone; and that by suitable manuring on this soil type, the yield of cotton can be doubled.

The residual effects of compost and phosphate, in the second and third seasons after application, are shown in Tables 5 and 6. Nitrogen does not persist beyond the year of application. Compost gives higher residual responses than phosphate. In both trials phosphate in the presence of compost has shown either only a very small effect or no effect. There is an indication that an increase in the rate of application of phosphate does not necessarily give a corresponding increase in yields. This had been noted in previous years in Trial (10), but there it might have been due to the fairly high level of fertility at the start of the trial.

The Lake Province Cotton Committee has supplied phosphate free, in the only form available at the time (super-raw) for application this 1951–52 season to African lands in exhausted hill-sand areas. It is hoped to continue such demonstrations for a number of years. It had been intended also to demonstrate in the 1951–52 season the effects of top dressed sulphate of ammonia on portions of these phosphate dressed lands, but supplies cannot be obtained in time; these applications will have to be postponed until next year.

Land Treatment.

Ridging and Tying.—In one trial under cotton there were no yield differences between poorer ridging and good ridging, nor between tied and not tied on either style of ridging. As last season there was an increase—though this season not significant—in the residual manurial response in the tied plots compared with the not tied (Table 3).

In a second trial, in the cotton section, at a good yield level for land which had not been manured for several years (control 972 lb. per acre) the 7% increase, good ridges tied compared with poor ridges not tied, was not significant. But in the bulrush millet section of the trial, a 14% increase in favour of the good ridges tied was significant.

Weed Control.—In a time-of-weeding trial cotton could not be planted until mid-January. In spite of this plots that were weeded early, and then kept clean, yielded over 900 lb. seed cotton per acre; the land was in good heart. Plots in which weed growth was allowed to develop after a first early weeding yielded only about 100 lb. per acre. A marked delay before starting the first weeding reduced yields to the same sort of level. Plots where *Tridax repens* was not checked also yielded very poorly. The top yields were from plots weeded early and then getting normal weeding.

Time of Planting.—All observations favour early cotton planting. This for the Lake Province entails planting before late December. The importance of this is now appreciated by the authorities, and by many of the cultivators. The need for early planting was approved

by the Sukumaland Federal Council. It is not unlikely, from observations on plant appearance, that the poorer growth and cropping resulting from delayed planting is linked to the leaching of accumulated soil nitrates following early heavy rains. The first plantings probably benefit from such nitrate accumulations.

Rotation.—In the rotation experiment this year no benefits were measured from rotating cotton and bulrush millet compared with continuous planting of these crops.

Cotton Breeding.

It was a season when jassid damage was slight, and therefore the benefits from jassid resistance were not generally apparent ; but in bulk growing in the Province the jassid resistance of Uk46 showed up. Bacterial blight caused considerable loss. It cannot be claimed that there is any worth-while resistance to bacterial blight in any of the Ukiriguru material, and this in spite of the fact that B_1 B_2 can be got out of most strains. In earlier reports the hope had been expressed that variations in the degree of resistance were showing up. But under conditions favourable to the spread of bacterial blight whatever resistance there may be is not enough. The adding of bacterial blight resistance to the main Ukiriguru strains is now a major part of the cotton breeding programme. The jassid resistance of Uk46 and Uk48 is probably sufficient for most situations ; the resistance of Uk48 is better than Uk46. The newly issued Uk51 is probably even slightly better. But to be safe higher jassid resistance has to be added to a number of the better Ukiriguru lots, as well as bacterial blight resistance.

The best strains now being worked with are from the 4/86, 5/57, 6/29, 6/318, 6/320, 6/322 families. These have been mentioned in earlier reports.

From 5/57 have come vigorous strains with good jassid resistance, good spinning qualities, and good ginning percentages, but slightly woody and late ; this affects their cropping in some years. 6/318, very free fruiting, would probably be one of the best Ukiriguru families if it had better jassid resistance ; this is to be added. From 6/320 have come two of the best of the more recent strains, 8/290 and 7/278. 8/290 is especially heavy cropping, but the heavy seed weight results in a lower ginning percentage. In district plots, 8/290 was the top yielder (seed cotton) in 7 out of 12 trials (trials of 25 strains), and it cropped outstandingly well at Ukiriguru and at Lubaga. Yield results from 1951 trials are given in Tables 7, 8 and 9. The yields show how the breeding work is progressing even without bacterial blight resistance ; and bacterial blight loss this year was quite appreciable. Given resistance there should be a big advance.

Strains of 7/150 ex 3/28 are being used as the parents in the adding of higher jassid resistance, and Albar 49 from Dr. J. B. Hutchinson has been used up to the present in the bacterial blight resistance hybridising programme. Some crossing with Stoneville 20 has also been done. But the new selections from Albar 51 from

TABLE 7.

Mz561, Uk46, Uk48—1951 SEASON.

Yield Results—1951 *Strain Trials* (*for details, see Tables* 8 *and* 9).

	Ukiriguru Hill Trial.			*Ukiriguru "Mbuga" Trial.*			*Ukiriguru (Nyashimba) Trials.*									*Lubaga "Ibushi" Trial.*		
	Yield seed cotton lb. per acre.	*Ginning %*	*Lint % of Uk46*	*Yield seed cotton lb. per acre.*	*Ginning %*	*Lint % of Uk46*	*Yield seed cotton lb. per acre. Trials.*				*Ginning %*	*Lint % of Uk46 Trials.*				*Yield seed cotton lb. per acre.*	*Ginning %*	*Lint % of Uk46*
							A	*B*	*C*	*D*		*A*	*B*	*C*	*D*			
Mz561	1067	33·1	89	1283	36·1	108	623	573	619	561	34·2	74	86	88	78	795	32·0	95
Uk46	1078	36·7	100	1150	37·4	100	784	619	660	672	36·6	100	100	100	100	787	34·0	100
Uk48	1083	37·0	101	1408	35·8	117	825	743	743	726	37·5	108	123	115	111	856	34·5	106
Sign. diff. ($P = 0·05$) ...	166	—	16	166	—	14	140	118	129	132	—	18	20	20	20	105	—	13
Standard Error	± 59·5	—	—	± 58·1	—	—	± 49·5	± 41·9	± 45·9	± 47·0	—	—	—	—	—	± 38·0	—	—

TABLE 8.

YIELD RESULTS—1951 STRAIN TRIALS.

Family and Strain.	*Ukiriguru Hill.*			*Ukiriguru "Mbuga."*			*Lubaga "Ibushi."*		
	Yield seed cotton lb. per acre.	*Ginning %*	*Lint % of Uk46.*	*Yield seed cotton lb. per acre.*	*Ginning %*	*Lint % of Uk46*	*Yield seed cotton lb. per acre.*	*Ginning %*	*Lint % of Uk46*
Uk46	1078	36·7	100	1150	37·4	100	787	34·0	100
Ex 5/57									
7/7*	987	38·6	96	1290	40·1	122	794	34·7	102
7/9*	1118	38·2	108	1439	38·9	133	915	35·0	120
Mean of two later strains	1050	42·1	112	1343	42·2	132	842	36·9	116
Ex 6/29									
8/64*	1086	40·6	112	1397	41·5	135	821	36·8	113
8/71	991	40·0	100	1279	38·4	119	871	36·4	117
Ex 6/318									
7/253	1080	35·7	97	1586	35·1	129	864	33·8	109
7/257	1075	36·1	97	1432	37·1	123	885	33·8	111
Ex 6/320									
7/278*	1218	36·9	114	1281	37·6	113	881	34·2	113
8/290*	1196	35·4	107	1649	34·4	124	1044	32·9	129
Ex 6/322									
8/333	1114	35·9	101	1215	34·4	98	905	34·8	117
8/341*	1044	35·9	95	1315	34·8	107	922	34·7	119
Sign. diff. ($P = 0·05$)	166	—	16	166	—	14	105	—	13
Standard Error	± 59·5	—	—	± 58·1	—	—	± 38·0	—	—
Details of Trials									
Design	7 × 7 balanced lattice.			7 × 7 balanced lattice.			7 × 7 balanced lattice.		
Plot Size	50 × 5 feet.			60 × 6 feet.			64 × 4 feet.		
Planting Date	18th December, 1950.			9th December, 1950.					
Spacing	5 foot ridges, 2 rows at 18 in. spacing, 2 plants per hole.			3 foot rows, 18 in. spacing, 1 plant per hole.			4 foot ridges, 18 in. spacing, 2 plants per hole.		

* Included in Uk51.

TABLE 9.

MORE RECENT SELECTIONS GROWN UNDER POOR SOIL CONDITIONS.

Yield Results—1951 *Strain Trials.*

Family and Strain.	*Yield seed cotton lb. per acre.*	*Ginning %*	*Lint % of Uk46*	*Ukiriguru (Nyashimba) Trials.*
Uk46	784	36·6	100	Trial A.
ex 5/57 Mean of 4 strains	817	39·4	112	
Uk46	619	36·6	100	Trial B.
ex 6/29 Mean of 10 strains	759	39·8	133	
Uk46	660	36·6	100	Trial C.
ex 7/150 Mean of 6 strains	775	38·0	122	
ex 4/86 Mean of 8 strains	763	39·5	125	
Uk46	672	36·6	100	Trial D.
ex 6/318 Mean of 3 strains	878	37·4	134	
ex 6/320 8/309	875	38·3	136	
ex 6/322 8/338	895	37·0	135	
Standard Error	(See Table 7 for S.E. of yields of single strains.)			

Details of Trials. 4 balanced lattices (5 × 5) designated A, B, C and D, each with the same standard strains as controls.

Plot size 25 × 5 feet. Planted 8th January, 1951. 5 foot ridges, 2 rows at 18" spacing, 2 plants per hole.

Namulonge are so very much better than Albar 49 that a new hybridising programme employing these will have to be started. They are better cropping, have fuzzy seeds, good lint qualities, and reasonable ginning percentages. As parents they will be incomparably better than Albar 49 which was naked-seeded, with harsh lint, and a low ginning percentage. Using the new Albar 51 lots should reduce the period of backcrossing necessary to get acceptable lint and cropping with resistance to bacterial blight.

Uk46 this season has cropped reasonably ; for 1951–52 it covers the whole Province. With jassid damage unimportant there could be little benefit from its quality of jassid resistance.

In earlier reports it had been suggested that the improvement in ginning percentage of Uk46 over Mz561 was somewhere about 1·5%. A mean of the ginning percentages from trials—Ukiriguru, Lubaga, and from 12 district plots (optimum percentages through a 12" roller gin)—shows 34·4% for Mz561, compared with 36·3% for Uk46 and 36·8% for U.K. 48—improvements of +1·9%, and +2·4%. (There have been considerable ginning percentage variations from soil type to soil type and from area to area. Seed weight variations are mainly responsible for these differences.)

Uk48, for 1951–52, covers one ginnery zone in Geita District. It has again shown up as a worthwhile improvement on Uk46. One interesting feature is that the yield increases of Uk46 and Uk48 over Mz561 show up considerably better on impoverished soil than on manured land (Table 7—Nyashimba Trials).

An Uk51 was constituted and issued for first multiplication by 80 growers in Kome Island. It was constituted from strains from the 5/57, 6/29, 6/320, 6/322 and 7/150 families.

Spinning results obtained since the last report was written, for which we are as in other years indebted to the Shirley Institute, continue to show Uk46 and Uk48 as generally similar in spinning qualities to Mz561. But there are, from time to time, reports of improvement in A.R. Mza grade. These new seed issues, not suffering from jassid attack, may be contributing to this better grade.

Pests and Diseases.

Pest damage was slight; the loss caused was on the whole unimportant compared with the damage by bacterial blight (*Xanthomonas malvacearum*).

Insect Pests.—On Ukiriguru, jassid attack was light, and the same could be said of most areas. In some areas the jassid resistance of Uk46 showed up late in the season.

There was very little American bollworm at Ukiriguru and little in the Province as a whole. The planting of early maize (before mid-January) had been discouraged by the authorities.

Stainer damage was lighter than usual, especially towards the South of the Province where stainers can cause considerable loss. At Ukiriguru, and in many of the district plots, the percentage of Grade "C" cotton was under 10 per cent., in the best five district plots averaging only 2½ per cent. At Lubaga the percentage of Grade "C" was 24 per cent.; from five district plots to the South of the Province the percentage averaged 9 per cent.

The rainfall distribution was such that there was no aphis build-up.

Lygus damage and *Helopeltis* damage were seen on very late-planted cotton in the Geita district.

In the three Overseas Food Corporation areas, there was serious pest damage to the cotton being grown experimentally. At Urambo, in the Western Province, severe loss was caused by *Calidea* and *Dysdercus superstitiosus*, and at Kongwa, in the Central Province, by *Calidea* and *Dysdercus fasciatus*. At Nachingwea, in the Southern Province, there was American bollworm loss, up to very severe loss, and damage by *Dysdercus intermedius*, and to a lesser extent by *Dysdercus fasciatus*, *Dysdercus superstitiosus*, and *Dysdercus cardinalis*. There was no *Calidea* damage at Nachingwea. The cotton at Kongwa and at Nachingwea was comparatively late-planted.

No red bollworm (*Diparopsis castanea*) was found on Nachingwea cotton, but reasonable numbers were found in native cotton on the south side of the quarantine area, beyond Masasi. The *Gossypioides kirkii* form of *Diparopsis* was found freely in thickets of *Gossypioides kirkii* towards Newala. Dr. C. Evans, Senior Entomologist of the Overseas Food Corporation, is breeding out specimens of the cotton *Diparopsis castanea* form, and the *Gossypioides kirkii Diparopsis* form.

Bacterial Blight (*Xanthomonas malvacearum*).—The damage by bacterial blight has been appreciable. It is obvious that work to reduce this loss must be one of the most important parts of the Ukiriguru cotton programme. A general impression is that the loss suffered is greater under poor growing conditions ; stand is reduced by the killing-off of plants just after the cotyledonary stage. On manured land the plant seems better able to grow away in part from the attack and still crop reasonably well, and post-cotyledonary stand reduction does not seem to be so important.

There is contact with Dr. Wickens' work at Namulonge, and with other work in Uganda. B_2 resistance is quite insufficient, and the conclusion now reached is that whatever the variations in the degree of resistance possessed within the Ukiriguru material these are not of importance if conditions favour the spread of bacterial blight. A strain possessing B_3 seemed to suffer less than B_2 neighbours ; and, apart from Albar, BAR7/8 (B_2 B_3) showed the best resistance of the material studied.

Albar 49, grown for the first time at Ukiriguru, was outstanding. Some plants were rogued out for slight vein infection. The remainder seemed to be very highly resistant. Strains nearby in the same field suffered considerably, all from natural infection. No worthwhile results were obtained from suspension sprayings. As part of the breeding programme for resistance, work on needle inoculation will be necessary, using *Xanthomonas malvacearum* inoculum—following the technique developed by Dr. Wickens—to ensure uniform infection in the separating of resistant and non-resistant segregates.

It is known that the seed of the area is considerably infected. Experiments must be made to test, under Lake Province conditions, what benefit there may be from seed treating. Carry-over trash infection may make seed-treatment not worthwhile.

PROGRAMME FOR 1951-52.

The programme covers the same general lines as in other years, with development in some sections.

A new twist is given to the cotton breeding work by the hybridising programme, to add bacterial blight resistance to the main Ukiriguru strains, plus better jassid resistance to some of them. Straight selection and testing continue. It will probably be worthwhile to make further seed issues, before the hybrid material is available for bulking.

In the study of resistance segregation, plant inoculation will be necessary using *Xanthomonas malvacearum* inoculum.

The husbandry work continues, with added interest in the effects of phosphate and nitrogen.

APPENDIX.

Origin and Special Characteristics of the Main Cotton Strains mentioned.

Lake Province "Local."	The commercial cotton in the Province prior to the issue of Mz561—mainly of Uganda Local origin.
Mz561.	A straight selection from "Local," first multiplied in season 1939–40.
Uk46.	A seed issue with fair jassid resistance, first multiplied in the 1946–47 season, and now completely replacing Mz561 as the commercial seed stock of the Province ; made up of the four best Ukiriguru strains and the three best Lubaga strains, available at the time.
Uk48.	A seed issue made up of four strains, 5/57, 6/29, 6/44 and 6/318, of better jassid resistance than Uk46. It was first issued for the 1948–49 season and covers the Buchosa zone in season 1951–52.
Uk51.	A seed issue made up of seven strains, with high jassid resistance ; first issued for the 1951–52 season.
4/86.	ex 1/45, ex Mz561 ; a constituent of Uk46.
5/57.	A derivative of 3/17, itself a straight selection from "Local."
6/29.	ex 2/388, itself a derivative of Mz561.
6/318.	ex 4/35, itself a derivative of Mz561.
6/320. 6/322.	ex 4/35 ; cousin strains to 6/318.
7/150.	A derivative of 3/28, itself a selection from Mz561 ; of high jassid resistance.
"Albar."	A general term for a group of selections from Nigerian Allen, highly resistant to bacterial blight : ex Dr. J. B. Hutchinson.
Stoneville 20.	An American variety resistant to bacterial blight ; ex Namulonge.
BAR7/8.	Blackarm resistant SP84 (B_2 B_3).

Received January, 1952.

KENYA.

NYANZA PROVINCE.

SUMMARY OF REPORTS ON COTTON, 1946-50.

BY

M. S. HASTIE.

Introduction.

The bulk of Kenya's cotton crop is grown in Nyanza Province on the lower areas near the shores of Lake Victoria, extending from the borders of Uganda to the borders of Tanganyika. The crop, in the past, has been grown exclusively by Africans as their cash crop, but this coming season, 1951–52, a small quantity of cotton is being grown by Indian farmers near Kisumu on what is normally sugar cane land.

The cotton area is extremely diverse, ranging from Lake level (3,700 feet) to 4,500 feet in altitude, on soils varying from the black cracking clays of the Kano plains to gravelly eroded soils on the uplands, and under a rainfall régime that is subject to wide variations according to altitude and topography.

In 1934 the Empire Cotton Growing Corporation was approached by the Kenya Government to send their Senior Officer in Africa, Mr. Milligan, to advise on improving the yield and quality of the cotton crop in Nyanza and the coastal strip near Mombasa. Early in 1936 Mr. Milligan came to Kenya and by April of that year had submitted his report on his findings and suggested lines of investigation for the various problems. The Kenya Department of Agriculture took steps to follow up the suggestions in the report and such trials as staff permitted have been laid out since.

In 1943 Mr. Jameson, Senior Botanist of the Uganda Department of Agriculture, visited Nyanza and made a report of his impressions. His visit was followed by those of Mr. Pearson (January, 1946 and January, 1949), Mr. Parnell (November, 1947), Mr. Prentice (November, 1949) and Dr. Hutchinson (November, 1950), of the Empire Cotton Growing Corporation. From their notes the following report has been compiled.

General.

Cotton production in Nyanza Province has never been large. Although no really satisfactory variety has been found, the major causes of low yields are poor husbandry and heavy losses from pests and disease. In 1945 the N17 stock was replaced by BP52 introduced from Uganda, but in 1948 N17 was again planted in South and part of Central Nyanza. The BP52 introduction was not very successful and difficulty was experienced in keeping the varieties pure. By 1950,

what had been known as BP52 was no longer recognisable as that variety.

The authors of the reports remark on the custom of late planting and the general opinion is that earlier planting would help to increase the yields. Parnell observed in his notes, written in November, " The plants were mostly very small, owing often to poor growth as well as late planting, and would be almost entirely dependent on further development for the production of any appreciable crop. They carried a few young bolls and were flowering ; in areas where further rains could be expected, particularly towards the north and up from the dry coastal areas, they could give a moderate yield of late crop in the absence of stainers." He goes on to say, " It may be noted that the large framework of early planted cotton enables it to put on a much heavier top crop than can be expected from the very small plants already described. Early planting is thus an advantage, even though most of the early crop may be lost." Prentice, on the other hand, felt that a case could be made for early and late planting and that there is insufficient reliable information to draw a conclusion as to which is the more profitable.

Further points raised on the question of cotton cultivation were those of spacing and tie-ridging. Parnell found the crop stand poor and felt that this was not due to heavy plant losses so much as to deliberate wide spacing, with the inevitable consequence of low acre yield. Since he made his report the generally accepted spacing is now 3 feet × 1½ feet. Where tie-ridging was found, the plants were better grown than their flat-planted neighbours and had the additional benefit of good soil conservation practice.

Pests and Diseases.

Bacterial Blight.

This disease, *Xanthomonas malvacearum*, is of paramount importance to the cotton crop in Nyanza Province. The full extent of damage caused cannot be accurately assessed because of the prevalence of *Lygus*. The combined effect of *X. malvacearum* and *Lygus* is such that only a small proportion of the potential crop is left for the cultivator. It is natural, therefore, that in any report on the Nyanza cotton crop bacterial blight should occupy a place of importance.

Bacterial blight is prevalent throughout the whole of Nyanza but its intensity varies with location—the greatest severity being at the higher altitudes which experience the heavier rainfall. Hail is common in the area, and in addition to the actual physical damage inflicted on the crop the follow up of blackarm in the lesions adds to the stress put on the plants.

Pearson notes, " The crop as a whole suffers severely from bacterial disease, *Xanthomonas malvacearum*, which is most active probably in September–October, accompanied or succeeded by an attack of *Lygus*, of variable severity and chiefly at the higher altitudes." Later he adds, " The effects of this disease, and of general growing conditions,

are such that I am doubtful whether cotton can be ever grown economically much above 4,000 feet."

On his 1949 visit Pearson found that the most striking form of bacterial blight was the damage to flower buds and young bolls. Typical angular leaf spot was rare, the disease taking the form of lesions along the leaf veins, on the stems of leaves or bolls, or at the base of bolls. Parnell and Hutchinson in their reports also comment on this form of *X. malvacearum*, the latter adding, " The blackarm phase (stem lesions and destruction of shoots) was generally serious and very often crippling. In some fields it could only be described as disastrous." Bacterial boll rot also accounted for considerable crop loss.

Lygus.

Damage sustained from *Lygus* attack is mentioned prominently in all the reports but there seems to be some doubt whether *Lygus* or *X. malvacearum* causes the greater plant losses. In view of the fact that the officers visited Nyanza during different years and in different months and that they had no sequence of observation to work on, little advantage is to be gained in speculation as to which agent is the more important.

The situation as found by Parnell was that *Lygus* is active from July to October with least intensity at the ends of this period. Very early cotton showed little damage at the early stages as the lowest fruiting branches were less regularly foreshortened while early cotton, which was fairly well grown, was seriously affected throughout the plant. On the other hand, late planted cotton, although small, was almost entirely free of damage. Taking the crop generally, Parnell found the worst attacked plants were those where growth had been good. The typical picture of a badly attacked plant is one where the leaves have been badly fretted and fruiting branches shortened, with very little crop except from late bolls and such early bolls as may have evaded attack.

Pearson in his earlier report suggests that *Lygus* might possibly be avoided, in areas where sorghum is the chief food crop, by late planting of existing varieties, or by early planting of blackarm resistant varieties. Cotton planted early (April/May) is particularly vulnerable (especially if budding is retarded by *X. malvacearum*) to *Lygus* migrating from sorghum when the latter is harvested. Later planting might evade this immigration. On the other hand, a blackarm resistant variety of more vigorous fruiting habit than BP52 and N17, planted early, might set a substantial proportion of its crop before *Lygus* immigration took place.

Stainers and stained cotton.

At the time of the visits of Parnell and Prentice damage by stainers (*Dysdercus* spp.) was unusually slight. Hutchinson found that 40% of the open bolls had stained cotton, the boll rot phase of bacterial blight being the predominant factor, especially in the north.

Other causes of staining found were internal boll disease and bollworm. Few stainers were seen, and it was difficult to believe that they had caused a significant attack of internal boll disease. In the light of the heavy infection found, Hutchinson suggested that if this was typical of the ultimate crop an intermediate grade should be created between " Safi " (high grade) and " Fifi " (low grade), with a price slightly above that of " Fifi " as an incentive to further sorting of the poorer pickings from which some fairly useful lint might result.

Pearson on his 1946 and 1949 visits found a quite different situation. The crop which had survived the blackarm and *Lygus* attack was badly damaged by stainer. The commonest species were *Dysdercus nigrofasciatus* and *D. superstitiosus*, the former predominating. Pearson thought that, on the scanty evidence available, the possibility of dealing with or evading stainer attack was not very hopeful. He described South and Central Nyanza as largely cultivation steppe or overgrazed grassland, carrying immense weed populations which early in the year are likely to include a large food supply for *D. nigrofasciatus* and *D. superstitiosus*, which are species essentially relying on herbaceous hosts. He suggested, " Improvement in land usage, particularly in pasture management, may perhaps eventually affect the stainer population, and of course it must be remembered that the less the acreage of cotton grown, the greater the concentration of stainer immigrants in the crop. The remedy against losing so much crop to stainer would therefore be to grow more of it." Subsequently Pearson suggested the possibility of insecticidal control of stainers on the Kano flats if large scale cultivation were started there.

Jassid damage is not noticeable in North Kavirondo ; it can be severe in the drier areas of Central and South Kavirondo, especially at the end of the season and on the more glabrous varieties such as N17.

Helopeltis.

Helopeltis damage occurs sporadically, the most severe cases being found at the higher altitudes in North Kavirondo, where occasional cases have been seen of early planted cotton completely crippled by stem lesions. Nowhere, however, is this pest generally of sweeping intensity.

Other pests and diseases.

Damage from bollworms (spiny bollworm—*Earias* spp., pink bollworm—*Platyedra gossypiella*, and false codling moth—*Argyroploce leucotreta*), acariose, *Verticillium* wilt, and *Nezara* were noted but they were not severe in any of the areas visited.

Conclusion.

The evidence of the reports summarised in this paper indicates the following immediate needs in a programme of improvement of the Nyanza cotton crop.

(1) A history of plant behaviour and pest and disease incidence over a number of growing seasons should be kept. This will

include studies of alternative hosts and migration behaviour of *Lygus* and stainers, and an account of the relative importance of internal boll disease and bacterial boll rot.

(2) The immediate requirement is a blackarm resistant variety of vigorous fruiting habit.

(3) Of the commercial varieties tried Uk48 would appear to be good starting material as it is jassid resistant, robust and free flowering.

(4) A great deal of improvement is required in agricultural practice before full advantage can be taken of suitable varieties which may be bred in the future.

[*Included by courtesy of the Kenya Government.*]

COTTON EXPERIMENTS, SEASON 1950-51

BY

R. O. WILLIAMS.

Variety Trials.

Experimental work consisted of :—

(*a*) A series of varietal trials using introduced S47 and Uk48 seed against the local BP52 and N17 seed. There were early and late plantings at each centre.

(*b*) Two varietal trials using S47 and four of its derivatives against BP52 (local) seed. These trials were carried out at the request of the Uganda Department of Agriculture.

Preliminary variety trials had been conducted in previous seasons, to test a wide range of material from Barberton (South Africa), Uganda and Tanganyika. On the results obtained, it was decided that S47 from Uganda and Uk48 from Tanganyika were the only varieties showing promise of excelling the stocks in current production. These two were therefore tested against the locally grown BP52 and N17 in trials designed to compare yields under conditions of early and late planting. The results have, on the whole, confirmed that replacement is worth while. S47 is now the commercial crop from the Uganda border to the Kano plains and it has been decided to replace N17 by Uk48 in South Nyanza as soon as seed is available.

Data are summarised in Table 1. Yields of varieties significantly superior to the lowest yielding variety in the trial are printed in heavy type.

TABLE 1.

VARIETY TRIAL DATA—NYANZA 1950–51.

Yields of Seed Cotton in lb. per acre.

	North Nyanza.				*Central Nyanza.*				*South Nyanza.*							
Locality.	*Adungosis.*		*Malakisi.*		*Ahero.*		*Kisiani.*		*Kendu.*		*Nyangwesso*		*Kochia.*		*Homa Bay.*	*Rangwe.*
Sowing Date.	9.6.50	21.7.50	14.6.50	17.7.50	7.6.50	13.7.50	6.6.50	15.7.50	13.6.50	2.8.50	12.6.50	1.8.50	9.6.50	19.7.50	12.6.50	20.6.50
N17 ...	440	594	624	204	**1018**	347	**1035**	707	1134	480	321	448	**721**	634	477	263
BP52 ...	481	547	580	**262**	**1050**	**541**	929	670	1235	563	396	570	663	768	473	317
S47 ...	546	636	597	**253**	864	282	894	745	1210	546	377	524	546	703	549	255
Uk48 ...	**562**	**739**	**704**	203	924	319	881	817	**1389**	511	**423**	486	**797**	968	578	345
S.E. ...	31	38	35	12	45	56	44	42	77	39	34	59	33	129	43	34
Uniformity	—	—	—	Poor	—	Poor	—	Poor	—	Poor	—	Poor stand	—	Excellent	Poor	—
Growth ...	Vigorous	Vigorous	Lanky	—	Good	—	Very Good	Good	Good	—	Excellent	Good	Good	Good	Poor	Poor
Lygus ...	Severe	Severe	Severe	Very Severe	Severe early	Moderate	Moderate	Severe	Severe	Mild	Severe	Moderate	Severe	—	Crippling	Moderate
Aphis ...	—	—	—	—	—	Severe	—	—	Severe	Severe	Severe	Severe	Severe	—	—	—
Bacterial Blight	Not Severe	Not Severe	Not Severe	Not Severe	Not Severe	Not Seen	Not Noticeable	Not Seen	Slight	Mild	Mild	Not Seen	—	—	Some Damage	Severe
Other causes of loss	—	—	—	—	—	Stainers present	Stainers jassid	Jassid	Hail	Hippo-potamus	Drought	Severe Jassid	—	Bud Shedding	—	—
Altitude	4000′	4000′	4500′	4500′	3900′	3900′	3800′	3800′	3700′	3700′	3800′	3800′	3900′	3900′	3800′	4400′
Layout ..	4×4LS.	4×4L.S.	4×4L.S.	4×4L.S.	4×4L.S.	R/B 3 reps.	4×4L.S.	4×4L.S.	R/B 4 reps.	R/B 4 reps.	4×4L.S.	4×4L.S.	4×4L.S.	R/B 3 reps.	4×4L.S.	R/B 4 reps.

Plot Size 1/48·4 acre in all cases

Summary of Variety Trial results.

The results are summarised in Table 2. They serve to emphasise, as in the 1949–50 trials, the superior yield obtained from early planting. The increase amounted to 137 lb. per acre, or about one third, in North Nyanza, and 260 lb. per acre, or 45%, in Kano and South Nyanza.

TABLE 2.

SUMMARY OF VARIETY TRIAL DATA—NYANZA 1950–51.

Mean yields of Seed Cotton in lb. per acre.

	North Nyanza.		*Kano and South Nyanza.*		*Homa and Rangwe.*	*Grand Mean.*
Variety.	*Early.*	*Late.*	*Early.*	*Late.*	*Early.*	
N17	532	399	846	523	370	532
BP52... ...	531	405	855	622	395	562
S47	571	444	778	560	402	551
Uk48	633	471	883	620	462	614
Mean	567	430	841	581	407	565

Seed cotton from both North Nyanza and South Nyanza trials was sampled, and ginning outturns determined on the samples. The percentage outturns of the four varieties were as follows :—

	North.	*South.*	*Estimated mean Lint yield (lb. per acre).*
N17	31·2	31·3	167
BP52	30·5	—	171
S47	31·8	30·8	172
Uk48	33·0	33·3	204

There was no difference in lint yield between the first three varieties, but Uk48 gave an overall increase of 20 per cent. Moreover, its behaviour was consistent. Reference to Table 1 shows that it gave the highest yield in 10 of the 16 trials, and was low in only two late sown trials.

The two trials of S47 and its relatives carried out at the request of the Uganda Department of Agriculture were planted at Sio Port and Adungosis. They were laid out at 5 × 5 Latin squares with plots of 1/66 acre. Data are given in Table 3.

TABLE 3.

SUMMARY OF THE DATA FROM TRIALS OF S47 RELATIVES.

Yield of Seed Cotton in lb. per acre.

Locality.	*Adungosis.*	*Sio Port.*
Sowing Date.	21.7.50	18.7.50
BP52	437	432
S47	457	541
6317	354	455
6354	473	538
6358	442	525
S.E.	28	50
Lygus	Severe	Not serious
Aphis	—	,, ,,
Bacterial blight ...	Severe	,, ,,
Other causes of loss ...	Bollworms	—
Harvesting completed...	Mid-February	End of January

Differences in seed cotton yield were not significant.

Lygus, blackarm and bollworms, and the bud, flower and boll-shedding which they cause, are the problems of cotton in Nyanza, and it is felt that breeding aimed at countering these afflictions and a study of the afflictions to determine methods of control are the next steps to be taken. Cotton plants can be grown well in Nyanza but bolls buds and flowers are shed in profusion and the potentiality of any variety is largely masked thereby.

Received February, 1952.

ANGLO-EGYPTIAN SUDAN.

PROGRESS REPORT OF THE PLANT BREEDING STATIONS, SEASON 1950-51

PLANTING AND PICKING DATES.

Area.	*Average Planting Dates.*	*Average Picking Dates.*	*Close Season.*
Gezira	10th Aug.–15th Sept.	30th Dec.–1st April	15th April–10th Aug.
Gash Delta	20th Aug.–20th Sept.	10th Jan.–30th April	30th April–20th Aug.
Tokar	7th Sept.–15th Oct.	1st Jan.–31st May	1st June–20th Aug.
Kordofan	15th June–15th Aug.	15th Oct.–1st March	1st March–15th June
Zeidab	1st May–15th May	1st Sept.–31st Dec.	1st Jan.–30th April
Equatoria	15th May–31st Aug.	1st Oct.–15th Feb.	31st March–15th May

INTRODUCTORY NOTE

BY

R. R. ANSON.

Egyptian Irrigated.

Gezira.—The season opened normally ; a few light showers were experienced in April, May and June, followed by heavy but well distributed precipitations in July.

Most of the cotton was sown on a good seed bed but heavy rains falling during the latter half of August caused flooding and several low lying patches had to be resown. Growth was slow until the end of October, when plants made a rapid recovery and set a heavy crop which ultimately produced the highest average yield ever known in the history of the Gezira.

At the Research Farm the highest yield obtained from any plot was 3,780 lb. of seed cotton per acre and the average for all varieties grown on the Research Farm was 2,189 lb. of seed cotton per acre.

White Nile Schemes.—Phenomenal yields were also returned from all the White Nile Schemes except Hashaba, where bollworm (*Diparopsis castanea* and *Earias insulana*) seriously reduced both yield and grade.

Gash and Tokar.—The ravages of bollworm (*Diparopsis castanea* and *Earias insulana*) reduced yields to disappointingly low levels, 441 lb. and 488 lb. seed cotton per acre respectively.

American Irrigated (Variety Wilds 11, extra long staple, $1\frac{1}{4}$").

At Zeidab, the Estate comprising 5,000 acres, now a private concern, produced an average yield of 1,575 lb. seed cotton per acre, but other pump schemes in this region were considerably below this figure.

American Rain Grown.

Nuba Mountains (Variety BAR SP 84, American 1″ staple).

The area planted amounted to 116,872 acres, which is a considerable increase over that of last season, 76,030 acres, but the average yield was somewhat lower. This low yield of 225 lb. seed cotton per acre was attributed to heavy continuous rains and concomitant waterlogging, heavy weed growth and blackarm spread (*Xanthomonas malvacearum*), a formidable combination which seriously reduced yields.

Equatoria (Variety BAR SP 84, American 1″ staple).

In this Province the season was more favourable; rains were good and well spaced. The total area planted, 17,625 acres, shows a considerable increase over that of last season, and the average yield of 462 lb. seed cotton per acre is considered satisfactory.

Table 1 demonstrates very clearly the contrast in yields between canal irrigated, flood irrigated and rain-fed cotton.

Table 1.

	Where grown	*Type of Irrigation.*	*Area Thousand acres.*	*Yield in lb. seed cotton per acre.*	
				1950—51	1949—50
Egyptian	Gezira	Canal	207	2,079	1,391
	White Nile	Canal	7	2,047	1,260
	Abdel Magid	Canal	10	1,764	1,575
	Gash	Flood	63	441	687
	Tokar	Flood	64	488	331
American	Zeidab...	Canal	5	1,575	1,189
	Other pumps	Canal	2	812	404
	Kordofan	Rain	117	256	264
	Equatoria	Rain	18	463	376

Publications.

Knight, R. L. (1952). "The Genetics of Jassid Resistance in Cotton." 1. The genes H_1 and H_2. (In press).

Knight, R. L. (1952). "The Genetics of Withering or Deciduous Bracteoles in Cotton." *J. Genet.*, 50, pp.392-395.

Elgar, G. L. and Rose, M. F. "The Grade Problem. A preliminary survey of factors in the field affecting grade." *Misc. Paper No. 52. Min. of Agr. Res. Div.*

THE GEZIRA STATION

BY

R. R. ANSON, M. F. ROSE AND L. C. HUGHES.

Meteorology.

Rains began with light scattered showers in April and these continued through May and June. The first heavy rain fell on 8th July and this was followed by heavy but well distributed rains from the

end of July until mid-October, after which no further rain fell. During the winter months, the average day and night temperatures were generally higher than usual. Average monthly readings are shown in Table 2.

TABLE 2.

Month.	Average Maximum °F.	Average Minimum °F.	Total Rainfall mm.	Average Relative Humidity 8 a.m.
April 1950	106	75	9·4	22
May ,, ...	107	75	5·4	29
June ,, ...	104	77	24·4	47
July ,, ...	94	71	149·6	77
August ,, ...	90	71	101·4	83
September ,, ...	94	70	83·7	77
October ,, ...	100	70	42·6	51
November ,, ...	98	65	—	33
December ,, ...	94	68	—	41
January 1951	94	56	—	41
February ,, ...	94	55	—	24
March ,, ...	101	64	—	26
April ,, ...	104	63	—	13

BREEDING AND VARIETY TESTING.

Breeding Plot (*plot* 56).

Breeding material was sown on 14th August, after rain, on a good seed bed. Germination was good, except in the case of BAR4/16, which was sown on rather low lying ground, but heavy rain at the end of August delayed resowings, and this, combined with unevenness of the soil, resulted in a very irregular stand. Affected progenies showed no signs of recovery until the end of October, when weak stunted growths began to catch up. By the end of November, a remarkable recovery had been made and final yields were satisfactory.

The breeding plot was practically free from blackarm. Jassid was present but its attack was mild.

The material planted and analysed is listed in Table 3. The main breeding material has now been reduced to three types, the Sakel types BLR14/16 and BAR14/1, and the 1730 type BAR4/16.

TABLE 3.

Strains.	Blackarm Resistance genes.	No. of progenies or bulks grown.	Character under observation.	Remarks.
Sakel types.				
BLR14/16	B_2	497	G.O.T.	40 progenies selected and bulked to sow a 3 fedd. propagation plot.
BAR14/1	B_2	14	G.O.T. and lint quality.	3 selected. To be grown in breeding plot
DS Early	—	5	G.O.T. and lint quality.	3 selected, bulked and stored.
DS Low Node No. ...	—	24		
1730 *types:*				
BAR4/16	B_2B_3	500	G.O.T. and lint quality.	60 selected to form a small bulk to sow a ¼ feddan isolation plot. One progeny for further observation in breeding plot.
BAR4/5	B_3	13	Improved boll opening	Discarded.
BAR4/11	B_2B_3	17		
BAR XL	B_2	15		
BAR XL–1	B_2	17		
JR1530	—	5	Lint quality.	One family retained for storing.

Observation Plot.

The following varieties and strains were grown for observation.

DS, BAR14/7, BAR14/1, BLR14/16, BAR XL-1, BAR XL, BAR4/16, XA (FF), X1730A, Karnak, Giza 7, Giza 30, Menoufi, BAR14/19, BAR14/21.

The new importations from Egypt were very badly affected by blackarm and showed almost 100% lodging. Six plants of Menoufi showed marked resistance to lodging. These were selected and will be grown in progeny rows in the breeding plot next season. BAR types showed satisfactory resistance to blackarm. BAR XL gave the very high yield of 10·4 kantars per feddan (3,276 lb/acre).

Leaf Curl Experiment.

The experiment was sown late (15th September, 1950) in order to encourage leafcurl spread. Twelve strains were grown, each a single row alternating with a row of DS (control). There were three replications. The plot was flanked by an angia of DS which acted as a leafcurl spreader.

There was no significant difference between resistant strains but all were significantly better than DS controls. Percentage infection 21 days after cutting back is shown in Table 4.

TABLE 4.

LEAFCURL EXPERIMENT 1950-51.

Per cent. infection on 10.5.51, 21 days after cutting back.

Strain.	*I.*		*II.*		*III.*		*Mean value (3 replications).*	
							DS.	*RDS.*
DS	80·0		80·0		33·3		64·4	
RDS1/49		16·0		8·7		16·0		13·6
DS	100·0		91·7		52·0		81·2	
RDS2/49		16·0		0·0		8·3		8·1
DS	87·5		87·5		56·0		77·0	
RDS3/49		8·3		0·0		0·0		2·8
DS	84·0		60·0		52·0		65·3	
RDS4/49		32·0		4·3		4·0		13·4
DS	66·7		91·7		41·7		66·7	
RDS5/49		12·0		8·0		16·6		12·2
DS	66·7		92·0		52·0		70·2	
BLR14/16		16·0		12·0		0·0		9·3
DS	95·8		96·0		20·0		70·6	
BAR14/1		8·0		16·0		8·6		10·9
DS	41·7		83·3		48·0		57·7	
BAR XL		8·0		4·2		0·0		4·1
DS	100·0		24·0		80·0		68·0	
BAR4/5		12·0		0·0		8·0		6·7
DS	96·0		60·0		68·0		74·7	
BAR4/11		8·3		8·0		4·0		6·8
DS	45·8		60·0		56·0		53·9	
BAR4/16		12·0		12·5		8·3		10·9
DS	60·9		50·0		32·0		47·6	
X1730A		8·0		12·0		4·0		8·0
							66·4	8·9

Since selections made for leafcurl resistance at G.R.F. often show greatly reduced resistance when grown under the more rigorous conditions at Shambat, all such selection work will be done in future at Shambat.

Standard Varietal Tests.

These tests occupied the usual sites. Sowing dates ranged from 13th August, 1950, for Turabi and G.R.F. to 17th August, 1950, at Hag Abdulla. Germination was satisfactory throughout.

At Turabi and Hag Abdulla plants were sprayed with DDT against jassid but the G.R.F. plot was not sprayed. At Hag Abdulla, DS significantly outyielded all other strains, but lint yield was the same as 1730A, which has a much higher ginning outturn. At Turabi DS outyielded other strains but was not significantly better than 1730A, BAR XL1, BAR14/7, BAR4/16 or BAR XL. At each of the above sites blackarm (*Xanthomonas malvacearum*) attack was very light. At G.R.F., however, where blackarm was severe, DS was significantly outyielded by all other Egyptian strains. Domains Sakel gave exceptionally high yields in areas where blackarm was not severe.

The Turabi and G.R.F. yields were good but at Hag Abdulla they were not exceptional.

The ginning outturn was considerably higher than usual at all three stations.

Blackarm resistant strains from Gezira and Gash grown seed did not differ significantly at any site.

TABLE 5.

GEZIRA VARIETY TRIALS 1950—51.

Yields of Seed Cotton and Lint in pounds per acre and percentage ginning outturn.

Strain.	*BAR Genes.*	*G.R.F.*			*Turabi.*			*Hag Abdulla.*			*Means.*		
		Seed Cotton.	*Lint.*	*G.O.T.*	*Seed Cotton.*	*Lint.*	*G.O.T.*	*Seed Cotton.*	*Lint.*	*G.O.T.*	*Seed Cotton.*	*Lint.*	*G.O.T.*
X 1730A (Gash)	—	2047	773	37·8	2342	865	37·0	1733	630	36·4	2041	756	37·1
BAR XL.1 ,,	B_2	2297	857	37·3	2309	852	36·9	1625	587	36·1	2077	765	36·9
BAR XL ,,	B_2	2244	851	38·0	2270	864	38·1	1586	594	37·5	2033	770	37·9
BAR4/16 ,,	B_2 B_3	2084	745	35·8	2099	720	34·3	1539	517	33·6	1907	661	34·7
BAR4/16 (GRF)	B_2 B_3	2034	730	35·9	2282	781	34·2	1516	514	34·6	1944	675	34·8
Domains Sakel (Gash)	—	1603	554	34·6	2412	798	33·1	1888	633	33·6	1968	662	33·6
BAR14/7 ,,	B_2	2190	700	32·0	2290	705	30·8	1694	528	31·2	2058	644	31·3
BAR14/7 (Gezira)	B_2	2202	704	32·0	2192	683	31·2	1733	538	31·1	2028	637	31·4
BLR14/16 (A/Magid)	B_2	2134	672	31·5	2160	666	30·8	1690	522	30·9	1995	620	31·1
BAR12/3 (BP 52) (Shambat)	B_2	1536	494	32·2	2060	656	31·9	1576	499	31·7	1724	550	31·9
Significant difference $p = 0·05$	—	288·4	77·8	—	214·2	72·2	—	112·7	38·2	—	—	—	—
Significance		***	***	—	*	***	—	***	***	—	—	—	—

TABLE 6.

SUMMARY OF PERFORMANCE OF CURRENT STRAINS IN GEZIRA VARIETY TRIALS UP TO AND INCLUDING SEASON 1950–51.

Variety.	Basic Type.*	Seed Cotton (lb./acre).						Lint (lb./acre).						Location.
		No. of Trials.	Variety.	X1730A.	Dom. Sakel.	Variety as % of X1730A.	Variety as % of Dom. Sak.	No. of Trials.	Variety.	X1730A.	Dom. Sakel.	Variety as % of X1730A.	Variety as % of Dom. Sak.	
Domains Sakel	S	12	1239	1294	1239	96	100	12	402	450	402	89	100	Northern Gezira.
DS1	S	5	996	1084	1021	92	89	5	324	381	329	85	98	Northern Gezira.
BAR14/7	S	3	1891	2033	2096	93	90	3	580	741	688	78	84	Northern Gezira.
BLR14/16	S	1	2160	2343	2412	92	90	1	666	866	798	77	83	Northern Gezira.
BAR NT2/41	S	7	1279	1319	1132	97	99	7	368	450	396	82	93	Northern Gezira.
X1730A	L	12	1294	1294	1239	100	104	12	450	450	402	100	112	Northern Gezira.
X1730A ex Tokar ...	L	4	1109	1124	1044	99	106	4	394	398	339	99	116	Northern Gezira.
BAR1730L	L	11	1281	1333	1288	96	99	11	460	464	415	99	111	Northern Gezira.
BAR1730L1	L	6	1213	1294	1253	94	97	6	430	462	407	93	106	Northern Gezira.
BAR4/16	L	3	1811	2033	2096	89	86	3	617	741	688	83	90	Northern Gezira.
BAR12/3	L	1	2060	2343	2412	88	85	1	657	866	798	76	82	Northern Gezira.
Domains Sakel	S	25	1586	1875	1586	85	100	25	501	660	501	76	100	Central Gezira.
DS1	S	6	1338	1525	1295	88	103	6	431	545	409	79	105	Central Gezira.
BAR14/7	S	4	1854	1789	1399	104	133	4	572	656	469	87	122	Central Gezira.
BLR14/16	S	2	1738	1686	1351	103	129	2	530	621	454	85	117	Central Gezira.
BAR NT2/41	S	8	1791	1750	1621	102	110	8	552	614	511	90	108	Central Gezira.
X1730A	L	25	1875	1875	1586	100	118	25	660	660	501	100	132	Central Gezira.
X1730A ex Tokar ...	L	4	1724	1766	1341	98	129	4	610	613	424	100	144	Central Gezira.
BAR1730L	L	13	1752	1763	1361	99	129	13	641	626	489	102	131	Central Gezira.
BAR1730L1	L	7	1827	1750	1439	104	127	7	647	627	458	103	141	Central Gezira.
BAR4/16	L	4	1930	1789	1399	108	138	4	669	656	469	102	143	Central Gezira.
BAR12/3	L	1	1537	2048	1604	75	96	1	495	774	555	64	89	Central Gezira.
Domains Sakel	S	8	1427	1570	1427	91	100	8	458	559	458	82	100	Southern Gezira.
DS1	S	4	1173	1476	1151	79	102	4	386	521	378	74	102	Southern Gezira.
BAR14/7	S	3	1495	1487	1466	101	102	3	455	532	487	86	93	Southern Gezira.
BLR14/16	S	1	1691	1733	1889	98	90	1	523	631	634	83	82	Southern Gezira.
BAR NT2/41	S	4	1734	1513	1393	115	124	4	524	524	428	100	122	Southern Gezira.
X1730A	L	8	1570	1570	1427	100	110	8	559	559	458	100	122	Southern Gezira.
X1730A ex Tokar ...	L	4	1421	1476	1151	96	123	4	509	521	378	98	135	Southern Gezira.
BAR1730L	L	8	1576	1570	1427	100	110	8	571	559	458	102	125	Southern Gezira.
BAR1730L1	L	6	1501	1465	1245	102	121	6	530	517	407	103	130	Southern Gezira.
BAR4/16	L	3	1464	1626	1631	90	90	3	484	532	465	91	104	Southern Gezira.
BAR12/3	L	1	1576	1733	1889	91	83	1	499	631	634	79	79	Southern Gezira.

* S = Sakel Group. L = X1730 Group.

TABLE 7.
SUMMARY OF SPINNING TEST REPORTS ON CURRENT GEZIRA STRAINS FROM VARIETAL TESTS.
1942–43 TO 1949–50.

Variety.	Effective length 32's.			Standard hair weight.			Corrected lea strength products.					
								Means of 80's cts.			Means of 100's cts.	
	No. of trials.	Mean.		No. of trials.	Mean		No. of trials.			No. of trials.		
		Variety.	Dom. Sak.		Variety.	Dom. Sak.		Variety.	Dom. Sak.		Variety.	Dom. Sak.
DS1	7	47·6	47·4	7	140	143	15	2274	2254	6	2263	2229
BAR14/7 ...	4	47·7	45·3	4	135	145	4	2702	2336	3	2277	2183
BLR14/16 ...	1	48	45	1	138	146	1	2577	2431	1	2371	2157
BAR NT2/41	12	51·6	48·6	12	149	141	12	2258	2547	12	2144	2427
BAR NT2/41.1	1	54	50	1	149	137	1	2355	2720	1	2180	2460
		Variety.	X 1730A		Variety.	X 1730A		Variety.	X 1730A		Variety.	X 1730A
BAR1730L ...	17	46·6	47·4	17	157	159	24	2062	2053	15	1926	1913
BAR1730L1 ...	8	47·2	46·1	8	160	160	16	1978	1931	7	1891	1790
BAR4/16 ...	4	45·5	44·7	4	161	163	4	1904	2048	3	1646	1682

Early Sowing Date Experiment (plot 222).

The object of this experiment was to determine whether early sown blackarm resistant strains, given slightly wider spacing (50 × 80 cm. instead of 35 × 80 cm., normal spacing), have any advantage in lint yield and grade over commercial varieties sown at the normal time.

After pre-watering (8th July, 1950) the plot was sown on 20th July, 1950, with five strains, five replications in randomised blocks. Much difficulty was experienced in getting an even supply of water on to the plot because, at this time of the year, the main feeder canal was very low. Fleabeetle (*Podagrica* spp.) appeared during the first week in August and did considerable damage, but it was eventually controlled by a heavy application of gammexane dust. The combined effects of fleabeetle and erratic initial waterings may have had a deleterious action on grade. In contrast to those from previous seasons, the results from the early sown material were disappointing. In the X1730 group, the early sown resistant strains showed a considerable increase in yield over commercial Sakel but this was due to the fact that commercial Sakel suffered a setback from severe blackarm attack (*Xanthomonas malvacearum*). On the other hand, early sown blackarm resistant strains were slightly down in yield and grade when compared with strains of the same origin sown at the normal time.

Of the early sown strains, BAR XL was significantly better than the other four.

TABLE 8.
EARLY SOWING DATE EXPERIMENT.
Yields of seed cotton and lint in lb. per acre and percentage ginning outturn.

Strain.	Early Sowing Date. Mean (5 replications)			Normal Sowing Date Mean (10 replications)		
	Seed Cotton.	Lint.	G.O.T.	Seed Cotton.	Lint.	G.O.T.
BLR14/16	1890	581	32·7	2134	672	31·5
BAR14/7 (Gash)	1802	562	30·7	2190	700	32·0
BAR XL-1	1902	689	36·2	2297	857	37·3
BAR XL ex Kumur	2240	800	35·7	2244	851	38·0
BAR4/16 (Gash)	1849	617	33·4	2084	745	35·8
X1730A	—	—	—	2047	773	37·8
DS	—	—	—	1603	554	34·6
Significant Difference $p = 0{\cdot}05$ ...	221·1	67·0	—	—	—	—
Significance	**	***	—	—	—	—

SHAMBAT STATION

BY

R. L. KNIGHT, H. DOUWES, R. L. CUANY AND J. SADD.

Introduction.

The two Cytogeneticists who had previously worked under Dr. Hutchinson, at Shambat, have been absorbed into the Cotton Breeding Section. The Corporation's former research station in Trinidad has handed down a rich heritage of fundamental research. With this behind them it is hoped that in the years ahead the Cytogeneticists will help still further to close the gap between cytogenetical theory and cotton breeding.

This season, breeding work on blackarm resistance has been virtually completed. On the American Upland side BAR7/8, carrying B_2 and B_3, is being reselected at Kadugli ; on the " Egyptian " side a new wave of BAR4/16, an X1730 carrying B_2 and B_3, is being reselected at Medani, and BLR14/25, a Sakel type carrying B_2 and B_3, was bred at Shambat this season.

Meteorology.

Rains started in May with a single heavy shower of nearly $\frac{1}{2}$ inch, after which no rain fell until July. The total rainfall for the year was nearly $6\frac{1}{2}$ inches, almost all of which fell in July and August.

Temperatures were mostly lower than usual and although the winter was rather warmer than average, the cool period continued until the end of April. Climatically the season was ideal for irrigated cotton and the long, but not too cold, winter resulted in a very successful out-of-season crop. During the period 1st May, 1950, to 30th April, 1951, there were only 176 days when the shade temperature registered 100° F. or over, 23 days with 110° F. or more and no days with 115° F. or over. These figures compare with averages for the previous eight seasons of 205, 34 and 2 days respectively.

ECONOMIC GENETICS

BY

R. L. KNIGHT AND J. SADD.

Genetics and Breeding.

Production of " Egyptian " varieties resistant to blackarm and leafcurl.

Domains Sakel derivatives.

BLR 14/16 (B_2 + leafcurl resistance).

It was mentioned in last season's report that a 5 feddan propagation plot of BLR14/16 was grown. This represented a second wave of this strain which had undergone a further year's roguing for leafcurl. Seed from this area was used to sow a 50 feddan nucleus in the Gash this season, adjacent to the 250 feddan increase plot sown with seed

from last season's selections. The 5-feddan area was grazed off by goats at the end of the season. Three feddans were chopped out and then the plants in the remaining 2 feddans were cut back and irrigated. Culling of leafcurl infected plants was carried out weekly on this ratooned portion. By the end of the summer 581 infected plants had been removed leaving 13,739 healthy ratooned plants. Seed from these plants was used to sow a 4-feddan propagation plot on 9th November, 1950, and in this only two plants developed leafcurl although the season was one in which leafcurl was general over the rest of the farm.

Spinning tests have shown BLR14/16 to have excellent lint quality, but the lint percentage is too low for it to be profitable to grow in the Gezira in its present form. Under Gash conditions this season its leafcurl resistance proved valuable and, in this particular season, more than made up for the low G.O.T. It will be seen from the Medani report that work is proceeding there to improve the G.O.T. of this strain.

BLR 14/25 (B_2 B_3 + leafcurl resistance).

In last season's report it was noted that 1/3rd feddan of BAR14/21 was sown on 11th January, 1950. By June, 50 per cent of the plants had been removed because they had severe leafcurl, leaving 383 plants all of which were ultimately attacked by leafcurl, though the symptoms were not very severe. Seed from these plants was used to sow 5 feddans in early October, 1950. This propagation plot was rogued regularly for leafcurl, about 3 per cent. of the plants being removed during the season. Over one ton of seed was obtained from this plot and this will go forward to the Gash and Abu Gutta (in the N.W. Gezira) for propagation next season. This wave of BLR14/25 will be almost immune to blackarm, but only moderately resistant to leafcurl.

Filtering BLR 14/25.

At the beginning of the season 700 plants were chosen at random for selfing and, later, a further 1,523 leafcurl free, fruitful plants were chosen for picking individually. These latter plants were not selfed. During the season all plants which developed leafcurl were removed and at the end of the season the remaining plants were cut back and allowed to sprout again, the bags being removed from any which showed leafcurl symptoms. 1,095 of the natural plants and 472 of the selfbred ones remained free from leafcurl at the end of the season. These will be grown as progeny rows at Medani next season and examined for lint quality, G.O.T. and leafcurl resistance. The bulked seed of the " filtered " strain will then be returned to Shambat where its leafcurl resistance will be strengthened.

In the re-transference of blackarm resistance from *G. arboreum* to Sakel, reasons for which were given in the 1948/49 report (p. 63), the 4th backcross progenies were grown and 5th backcross seed obtained. Those families carrying B_4 will be handed over to the

Cytogeneticists next season for making gene homology tests with the B_4 material previously transferred.* The gene B_{6m}, a strong blackarm resistance intensifier from *arboreum* was also carried to the 5th backcross successfully in this " repeat " transference, while the material from the original transference, carrying B_{6m}, is being crossed with B_2B_3 Sakel and B_2B_3 1730 with a view to obtaining *barbadense* strains immune to blackarm.

In the hybridization between tetraploid *herbaceum* (Wagad 8) and Sakel, the *herbaceum* blackarm resistance gene was successfully carried to the 5th Sakel backcross and 6th backcross seed was made for sowing next season.

Fifth backcross progenies carrying B_5, the resistance gene from Grenadines White Pollen, were grown and seed of 6th Sakel backcross type was obtained for next season.

B_7, the resistance gene from Stoneville 20, was successfully carried to the 4th Sakel backcross progeny stage.

Production of blackarm resistant strains of American Upland.

Last season, 213 resistant plants in C(48)4, a heterogeneous BP52 stock from Namulonge, were selfed. This season, these were grown in progeny rows, in an area isolated from other cotton, and sprayed with blackarm inoculum. Rows splitting for B_2 were removed and the plants in the remaining rows were then rogued for maximum resistance, so as to build up minor resistance genes. This type was given the number BAR12/9. Seed of BAR12/9 was sown out-of-season on 20th November, 1950, and the resulting plants were again heavily rogued for maximum blackarm resistance. This strain has been given the number BAR12/9.1. Next season BAR12/9 and BAR12/9.1 will be compared for blackarm resistance grade and the roguing process will be carried a stage further.

Last season, resistant plants in C(48)4 were bulk-crossed with BAR7/8 (a B_2B_3 Upland). This season, the F_1 was crossed with BAR12/9 and the seed produced sown out-of-season. Plants in this first backcross, showing maximum resistance, were crossed with BAR12/9.1. The object was to add B_3 to a Uganda BP52 strain already homozygous for B_2, while at the same time building up a minor resistance gene complex.

In view of the performance of BAR11/5 in Equatoria, it was decided to proceed with the production of a similar type carrying B_2 and B_3. This work had been temporarily stopped a few years ago. Accordingly, BAR11/5 (B_2) and BAR11/6 (B_3) were crossed and the F_1, grown out-of-season, was bulk selfed : from this it is hoped to produce a type homozygous for B_2 and B_3 next season.

* Knight, R. L., 1948, *J. Genet.*, **48**, pp.359–369.

Jassid Resistance.

The economic and genetic background of this line of research was given in our 1947–8 report (p. 60). Since then the following figures have been released for publication. In 1949, 143,000 acres of cotton in the Sudan were sprayed against jassid and in 1950 the figure rose to 178,000 acres. The yields of seed cotton in kantars of 312 lb. per feddan obtained in the Sudan Gezira are shown in Table 1.

Table 1.

	Sprayed.	*Unsprayed.*
1945—46	4·53	3·62
1946—47	4·25	2·76
1947—48	3·74	2·44
1948—49	4·01	3·71
1949—50	5·10	3·49

Clearly, the early production of jassid resistant cottons for the Gezira is important to the Sudan.

This season, a blackarm (B_2) resistant and leafcurl resistant Sakel, homozygous for H_1, was synthesized for use as a backcross parent in the hairiness transferences. This strain was given the number BLJR14/23 : it will be used as backcross parent until a similar type carrying B_3 as well as B_2 is available.

In the transference of MU8b hairiness to Sakel, the full MU8b hairiness was recovered in F_2s of 3rd Sakel backcross type and plants with maximum hairiness were crossed with BLJR14/23 and the hybrids, grown out-of-season, have yielded adequate selfbred seed for sowing next season. The initial sterility which was such a difficulty in the earlier generations of these crosses has now been entirely removed.

In the transference of hairiness from Philippines Ferguson to Sakel, the policy has been to separate the hair length intensifiers and minor hairiness genes from the major hairiness gene and transfer them to a Sakel homozygous for H_1 and B_2. In this line of transference, plants showing good length of hair were recovered in the 5th backcross F_2 (the last two crosses having been to H_1H_1 Sakel) and 6th backcross F_1s were grown and selfed.

Work with hairiness genes from *G. arboreum*, *G. herbaceum*, *G. tomentosum*, *G. mustelinum*, *G. punctatum*, St. Ignatius, and Hairy Giza 36 was continued.

Transference of lint strength from G. thurberi to Sakel.

This season a number of F_3 lines of *G. 'thurbadense'* × Domains Sakel[3] were grown and plants with Pressley strength indices (tested by the Shirley institute) up to 10·2 were selected. The BLR14/16 controls had a Pressley index of 7·7.

As was pointed out in this report two years ago, this work has two possible uses. Firstly, it gives a chance of greatly increasing the strength of Sakel; secondly, in jassid resistance breeding, should the addition of leaf hairs materially increase the fibre hair weight, this material with its very low standard hair weight would be useful for again reducing it.

Yield.

Boll locule number.—In the transference of an increased number of locules from *sanguineum* to Sakel, plants with a mean locule number of 3·77 were recovered in the F_2 of the 3rd Sakel backcross but the distribution suggested that no major gene was involved.

In the transference from tetraploid *herbaceum* (Wagad 8) one plant with a mean locule number of 3·63 was obtained in the 4th Sakel backcross F_1.

The 4-loculed character from Philippines Ferguson was carried to the 5th Sakel backcross F_1, in which one plant with a mean locule number of 3·70 was obtained and further backcrossed to BLR14/16.

An investigation of the genetics of boll locule number was started in a number of Upland strains.

Ovules per locule.—*G. auritum* (obtained through the courtesy of the Plant Industry Station, Beltsville) was found to have 9–13 ovules per locule with a marked mode at 11. BLR14/16 has 5–6 and the F_1 of these two varieties had 6–10 ovules per locule with a strongly marked mode at 8. First Sakel (BLR14/16) backcross seed was obtained for sowing next season.

Resistance to wind damage.

In the northern Gezira, there is usually a considerable loss in grade owing to cotton which is blown out of the bolls on to the ground. Cook and Hubbard (1926)* described *G. contextum* as having the inner surfaces of its mature carpels finely and closely wrinkled so that the ends of some of the lint fibres are caught and held in these wrinkles. Some of the fibres appeared to them to be held by hardened exudation. It seemed probable that this character would be valuable if it could be transferred to Sakel, with a somewhat reduced expression. Accordingly *G. contextum* was crossed with BLR14/16 and the F_1 was grown out-of-season. The *contextum* type of "adhering boll" proved partially dominant in F_1.

This line of work will be handed over to Medani Station next season where bollworm damage is less regularly severe.

Diseases and Pests.

Leafcurl was severe on all susceptible types.

Pink bollworm (*Platyedra gossypiella*) was severe and Egyptian bollworm (*Earias insulana*) was troublesome also. Jassids were less noticeable than usual.

* Cook, O. F. and Hubbard, J. W., 1926, *J. Hered.*, **17**, pp.463–472.

CYTOGENETICS

BY

H. DOUWES AND R. L. CUANY.

Relationship between Wild and Cultivated Species.

Lint character investigations by T. Kerr, Fiber Technologist, U.S.A., have shown that the alleged amphidiploid *G. arboreum* × *G. raimondii* (as mentioned in the 1949/50 report, p. 36) does not contain the genom of *G. raimondii* after all.

It is likely to be a doubled *G. arboreum* × *G. herbaceum* outcross.

Progress was made in the attempt to widen the range of synthetic allopolyploid material. Seeds have been obtained of the cross *G. arboreum* × *G. klotzschianum* var. *davidsonii*. A few F_1 plants were grown of *G. hirsutum* (MU8b) × *G. gossypioides*, but these unfortunately died without fruiting. Finally a hybrid of AD.AB. constitution was made by crossing *G. "thurboreum"* with *G. "arbanomalum"*.*

Relationships of Wild Species.

G. somalense × *G. areysianum*.—Ten F_1 plants were grown. They were very vigorous and produced natural seeds freely and some selfed bolls. Chromosome pairing was almost normal. Thus *G. areysianum* belongs to the E genom.

G. anomalum × *G. areysianum*.—Twenty-five F_1 plants were grown. They were weak, and only five reached the flowering stage. Chromosome pairing was very poor indicating rather distant relationship between the parents.

G. anomalum × *G. triphyllum*.—Thirteen F_1 plants were grown, and produced plentiful natural seed and some selfed bolls. Chromosome pairing was almost complete, indicating that *G. triphyllum* belongs to the B genom.

G. gossypioides hybrids.—The hybrids mentioned in last year's report (p.38) showed poor germination. Only four seedlings of *G. anomalum* × *G. gossypioides* and one of *G. stocksii* × *G. gossypioides* reached the two-month old stage. They were weak, none growing higher than four inches, and all died within three months. Further crosses will be made.

New Accessions of Wild Species.

There are now six accessions of *G. sturtii* in the collection.

* *G. "arbanomalum"* = *arboreum* × *anomalum* doubled with colchicine.

The accession of *G. robinsonii* reported last year (p. 37) has now flowered, but no selfed seed has yet been obtained. The flowers of *G. robinsonii* are mauve with a deep red spot, and the bracteoles are triangular and entire. The only floral difference from *G. sturtii* is the pink colour of anthers and pollen. The chromosome number has been determined as $2n = 26$.

G. robinsonii was crossed with *G. sturtii*, and set freely. The hybrids are vigorous but have not yet flowered. Some natural seed was set on *G. robinsonii*, but this gave plants all of which were indistinguishable from *G. sturtii* × *G. robinsonii* F_1s.

Genetics.

Blackarm Resistance.

It has been shown that Acala UA 2–15 carries the gene B_2.

The resistant W. African varieties are maintained in seven stocks, the best having grade " 3–4 " resistance. A strain of Samaru 26C, with grade " 3–4 " resistance, has been made homozygous for resistance and bulked under the number BAR18/3.

A number of types were received from Coimbatore (South India) for blackarm grading. Most had B_2 resistance, and the most promising of these, including three lines of the constitution *G. herbaceum* (1027 ALF) × *G. hirsutum* (Dharwar American) backcrossed to Dharwar American, have been sent to Namulonge for further study.

The transference of a number of flower, leaf, habit and lint characters to leafcurl resistant (blackarm susceptible) *barbadense* was continued, to provide a series of genes on a common background for linkage tests. Most of the characters concerned occurred in plants that were fully or almost fully susceptible to blackarm (i.e. lacking major B genes). Direct crosses of such types were therefore made with standard *barbadense* and *hirsutum* strains carrying known B factors.

The transfer of B_2 and B_3 from BAR stocks, and also of hairiness from MU8b, to Wilds 16 (strain SUS16/1) is progressing.

Miscellaneous genes in New World cottons.

Genetic studies on smooth boll, striped boll, and curly-rogue are in progress. The leaf shape gene of narrow leaved *G. hirsutum* race *palmeri* has been crossed with Okra and Super-Okra to test homology.

Asiatic linkage tests.

First backcross and F_2 generations have already shown that the linkage of *P* to *Ne* is closer in interspecific *herbaceum* × *arboreum* than within *arboreum* crosses, the crossover value being of the order of 6 per cent. and 14 per cent. respectively. The production of suitable tester stocks is proceeding.

Homology of transferred Asiatic genes.

The Asiatic red leaf gene R_2, and the blackarm gene B_4 have each been transferred to *barbadense* twice. The modes of transference were cytologically different in the two cases: Harland transferred R_2 via an *arboreum*-Upland triploid into Upland, and thence Knight transferred it into *barbadense*. Knight transferred R_2 from an *arboreum-barbadense* auto-allotetraploid, by repeated backcrossing to *barbadense*. Both transferences of B_4 were by the latter method. It is important to check whether the second transferences went into the same loci as the first, as otherwise all homology tests against a known transferred gene are rendered unreliable. Material of the four gene transferences was made available by Dr. Knight and F_1 progenies of the two R_2 transferences were grown out-of-season for selfing.

Type Collection.

Maintenance has gone on as usual: this year most types were grown with the oldest existing seed planted alongside more recently harvested seed, to enable any recent outcrosses to be rejected, and also to preserve the maximum of variability present in the oldest stocks.

Among the year's new accessions have been four *punctatums* from Kordofan Province, two of *G. arboreum* race *soudanense* from Kordofan Province, two from Darfur and one from Aweil in Bahr-el-Ghazal Province. A fresh accession of *punctatum* from Australia (Darwin) proved very similar to the earlier one in our collection, from Port Essington. Both are relics of the cotton industry founded in several North Coast settlements of the early 19th century. During the season seed has been received from Aden, French West Africa and Yugoslavia and will be grown next year. The survey of South African *herbaceum* types will be completed when their blackarm resistance status has been determined.

Diseases and Pests.

One plant of *G. thurberi* was cut back and later developed intense leafcurl. This is the first record of severe leafcurl on that species. *G. somalense* is the most susceptible of the diploids while *raimondii* can contract the disease. Mealybug is a troublesome pest in the wild species plots, as it causes a gall-like distortion of the growing points.

PROGRAMME FOR 1951-52.

All the lines of work shown in the above report are being continued, except where otherwise indicated.

KADUGLI STATION

BY

K. C. BARLOW.

Meteorology.

Up to July the rains were normal, but from early July until the middle of September rains were much heavier than average. Rain fell on 20 days during August. During late July, August and early September the sun was rarely seen, there being low cloud most of the time.

Roads became impassable during this period. Large areas of the low clay plains were flooded for a month or more. The hills became saturated with moisture to such an extent that khors flowed continuously. In several places clear water was still running from springs in January. Evaporation was very slow and the soil became waterlogged.

Table 1.

Rainfall mm.

	March.	*April.*	*May.*	*June.*	*July.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Total.*
Kadugli 1940–49	1·8	8·3	99·5	95·0	143·9	165·0	120·6	74·2	3·5	711·8
Kadugli 1950 ...	—	39·7	112·3	109·6	174·3	252·3	230·0	98·6	4·7	1,021·6
Dilling	—	—	13·3	112·0	38·6	240·3	148·3	20·5	—	573·0
Lagowa	—	—	81·0	64·5	190·0	209·0	145·5	145·5	—	835·5
Talodi	—	66·5	136·5	98·5	221·0	370·0	216·5	51·5	—	1,160·5
Kalogi	—	32·3	87·5	127·8	157·5	288·5	135·5	60·1	0·4	889·6
Abu Gubeiha ...	—	—	14·9	124·1	191·4	215·7	155·5	66·2	—	767·8
Um Berembeita...	—	7·3	51·9	61·0	97·9	269·6	133·0	22·0	—	642·7
Abbassiya ...	—	38·5	37·0	105·5	150·5	238·0	165·5	34·0	—	769·0

Table 1A.

Temperatures °F.

	Mean Max.	*Range.*	*Mean Min.*	*Range.*
Period Resting : December, 1949—May, 1950	97	106—88	66	75—57
Period Growth : June—November, 1950 ...	90	97—82	68	73—63

Commercial Cotton.

The seed issue of 45,300 kantars (99 lb.) was a record but owing to waterlogging and excessive weed growth in the southern areas the final crop was disappointing. In the north, however, rainfall though adequate was not excessive. The higher and better-drained soils in the south grew good crops of cotton. Table 2 summarizes final returns.

Table 2.

Ginnery.	*Estimated Acres.*	*Seed Cotton Purchased. Kantars of 99 lb.*	*No. of Bales—Lint.*				*No. of Bales of 400 lb.*
			G. I.	*G. II.*	*G. III.*	*Total*	
Dilling	16,962	51,339	3,443	1,140	416	4,999	4,399
Kadugli...	31,904	82,316	6,603	1,986	190	8,779	6,654
Lagowa...	19,970	50,093	4,012	1,209	89	5,310	4,035
Talodi	15,000	29,595	1,549	1,414	570	3,533	2,649
Kalogi	12,000	28,584	2,006	1,605	694	4,305	2,421
Abu Gubeiha	16,000	29,710	—	—	—	4,535	2,550
Um Berembeita ...	5,000	7,847					
Abbassiya	5,500	11,164	2,302	367	148	2,817	2,500
Semeiha	—	4,387					

An outstanding feature of the year was the reintroduction of travelling cotton markets which now serve areas lying some distance from the ginneries.

Blackarm was serious in the commercial crop but bollworm damage showed a marked reduction in areas where crop hygiene was effectively practised. Stainer bugs (*Dysdercus* spp.) damaged cotton in all areas except Kadugli and Abu Gubeiha where more vigorous control was conducted.

Genetics and Breeding.

The breeding plot was composed of :—

(1) BAR7/8, 46 progeny rows.
(2) Wilds 11, 105 progeny rows, selected for earliness.
(3) BAR SP 84 Selections, 9 special bulks.
(4) BAR NT96/40 × BAR SP84 F_1 and Intra BAR SP84 F_1s.

All four groups were sown on 28th June and grew well. During August the plot became severely waterlogged and all lower places had water lying for several weeks. This resulted in irregularity. Even small undulations were reflected in plant vigour. Many plants were so retarded and small that the selfing programme had to be extended in order to produce sufficient seed cotton for laboratory analysis. Picking of the plot was later than usual and owing to late rains secondary growth was prolific.

Group (1). Much material in the progeny rows had been waterlogged badly and was useless for analysis. Lint index and seed weight were markedly depressed. The healthy plants showed considerable variation in all characteristics both within and between progeny rows. This material was selected from bulk BAR7/8 grown at Gannaya in 1949–50. A bulk of some superior progenies was made and given the number BAR7/8.1.

Group (2). In 1948 and 1949 the mean node number in this group was 6.5. This season the mean for 105 progeny rows was 6.6. Clearly further selection would be pointless.

Group (3). Field observations were masked by waterlogging. As in previous work on BAR SP84, however, the better quality types appeared least vigorous. The best types of similar characteristics will be bulked.

Group (4). These F_1s grew vigorously. A sample of seed cotton from 100 bolls gave 1·3 lb. for the BAR NT96/40 × BAR SP84 F_1s compared with 1·4 lb. for BAR NT96/40 and 1·1 lb. for BAR SP84. The Intra BAR SP84 F_1s showed the increase in vigour and uniformity expected. The F_2 seed has been stored as work on these types is being suspended in favour of straight selection on BAR NT96/40 and BAR7/8.

Cotton Propagation.

Kamina Farm.

8131 *and* 8134.—These two Kadugli selections (ex CL 20–4) were sown in ½ acre isolation plots—the purer seed being sown in the centre. They were vigorous from the start, the site being mainly well-drained. These types have had good reports regarding length, fineness and maturity from the Shirley Institute but strength is lower than the combination of these factors would suggest. They are also rather small bolled and open badly, making picking difficult. 8131 gave a yield per acre of 965 lb. of seed cotton and 8134 gave 1,255 lb.

U4 × MU8 Derivatives.—A332, A449 and A455 were sown in isolated plots of ⅛, ¼ and ¼ acre respectively. All were severely waterlogged and were unable to grow away from the blackarm attack which occurred at the same time. Only 143, 148 and 119 lb. of seed cotton per acre were recovered respectively.

El Effein Propagation Farm.

The varieties BAR SP84.1, Pump Scheme Strain and BAR NT96/40 were sown in 1 acre plots. Initial germination was excellent but waterlogging retarded growth severely in Pump Scheme Strain and less severely in BAR NT96/40. Drainage was impossible as the whole of the extensive clay plain at El Effein was flooded for two months. Blackarm, acting under very humid conditions on a stunted plant, caused great damage despite the protection afforded by the gene B_2 in the case of BAR SP84.1 and BAR NT96/40. A large number of growing points were killed. As the plots dried out in October secondary growth appeared which resulted in an improvement. The underground water supplies after such a long period of flooding enabled picking to extend into early February. Planted on 22nd June, these plots had been growing seven months before the final picking. Pump Scheme Strain, having an inherently longer growing period, made good use of the reserves of underground water. Final yields are shown in Table 3.

Table 3.

	Seed cotton per acre.
	lb.
BAR SP 84.1	294
Pump Scheme Strain	248
BAR NT 96/40	241

Main Farm Kadugli.

994–6.—A small plot of this selection from BAR SP84 was grown but was badly affected by waterlogging and gave a yield of only 252 lb. of seed cotton per acre.

Cotton Variety Trials.

Two variety trials were sown on 28th June and a good sequence of following rains resulted in an excellent stand. There were five replications of nine varieties in each trial. During August, when the rainfall was unusually heavy, all plots suffered from waterlogging which was progressively more severe from one end to the other. As a result block variation was considerable. The yield of the first replication was in both trials about three times that of the fifth. This replication was therefore excluded when making up spinning test samples and in the final analysis.

As waterlogging became less severe during September, growth was accelerated. The September rainfall was well above average and not much less than that of August, but a large proportion of it fell in the first few days of the month and thereafter in heavy thunderstorms separated by sunny periods. October rainfall was also above average. The early waterlogging and late rains resulted in a late crop. In the early pickings there was much blackarm staining at the base of the locules but later pickings were clean.

Miscellaneous Variety Trial.

The yields and G.O.T.'s of the varieties tested are listed in Table 4.

Table 4.

Variety.	*Lb. lint per acre.*	*G.O.T.*
449...	210	32·4
BAR SP84	241	31·7
PSS	225	28·8
8134	225	31·7
332...	251	30·7
8131	229	31·3
455...	250	32·3
BAR7/8	211	33·7
994-6	199	32·7

There was no significance between varietal differences. The high resistance to blackarm of BAR7/8 which carries the genes B_2 and B_3 was outstanding.

The weak growth of the U4 × MU8 derivatives (332, 449, 455) under Nuba Mountains conditions was noteworthy. Heavy storms invariably caused lodging.

Samples from this trial were tested for maturity using the Goldthwait technique. Results did not conform to the spinning test reports. It is suspected that fineness affects the differential staining and complicates the picture.

None of these varieties can be considered suitable for distribution in the Nuba Mountains until it is protected from blackarm by the combination of the genes B_2 and B_3: BAR7/8 already carries them.

Intra BAR SP84 Variety Trial.

Various selections from within BAR SP84 were tested against a control of the original material, giving the results tabulated in Table 5.

TABLE 5.

Variety.	*Lb. lint per acre.*	*G.O.T.*
861...	264	33·5
BAR SP84	312	32·0
BAR SP84.1	259	33·3
862...	298	32·8
857...	265	33·2
840...	224	32·2
992-3	192	32·3
841...	209	32·1
853...	263	34·1

Differences needed for significance were 60·5, 82·0 and 109·7 lb at the 5 per cent., 1 per cent. and 0·1 per cent. levels respectively.

As in the 1949–50 season the higher quality types, 840 and 841 are low in yield. 992–3, which was tried for the first time this season, also falls into the high quality, low-yielding group.

Staining of samples to assess maturity gave similar results for all varieties.

Yields of varieties which have been tried for several seasons at Kadugli are summarized in Table 6.

TABLE 6.

YIELDS OF CURRENT VARIETIES 1950/51.

Variety.	*Seed Cotton.*				*Lint.*			
	No. of Trials.	*Rotls per feddan.*		*Variety as % of PSS.*	*No. of Trials.*	*Rotls per feddan.*		*Variety as % of PSS.*
		Variety.	*PSS.*			*Variety.*	*PSS.*	
PSS	57	964	964	100	48	279	279	100
BAR SP84	14	1003	1046	96	14	329	306	108
BAR NT 96/40	4	1503	1504	100	4	479	442	108

Variety.	*Seed Cotton.*				*Lint.*			
	No. of Trials.	*Rotls per feddan.*		*Variety as % of BAR SP84*	*No. of Trials.*	*Rotls per feddan.*		*Variety as % of BAR SP84*
		Variety.	*BAR SP84*			*Variety.*	*BAR SP84*	
BAR SP84	17	1101	1101	100	17	360	360	100
BAR7/3	1	1779	1788	99	1	598	570	105
BAR7/8	2	1237	1340	92	2	417	431	97
840	2	1153	1382	83	2	377	441	85
841	2	1110	1382	80	2	363	441	82
853	2	1182	1382	86	2	409	441	93
857	2	1168	1382	85	2	398	441	90
861	2	1373	1382	99	2	471	441	107
862	2	1276	1382	92	2	441	441	100
8131	2	1376	1340	103	2	424	431	98
8134	2	1397	1340	104	2	435	431	101
BAR NT96/40	4	1503	1497	100	4	479	492	97
PSS	14	1046	1003	104	14	306	329	93

Manurial Experiment.

This trial involved nitrogen, phosphate and potash in the form of ammonium sulphate, calcium superphosphate and potassium sulphate. There were three levels of fertilizer: (1) no fertilizer, (2) 150 lb. per acre, (3) 300 lb. per acre. The layout used was the standard 27 plot arrangement.

The fertilizers were stirred into the soil just before sowing.

During the wet and overcast weather of August the plots became waterlogged in parts. Fortunately this tended to run across plots but undoubtedly the errors were increased. Variation in vigour was extreme within plots. A certain amount of admixture of soil solutions probably took place in the waterlogged areas. The plot size was therefore reduced and errors increased.

No straight effects were detectable from the three fertilizers, the only significant portion being the interaction P linear × K linear. This can be interpreted as meaning that P_2 outyields P_0 in the absence of K but not in the presence of K_2.

These results are somewhat puzzling as heavy clay soils in this rainfall belt usually show a marked response to nitrogen and nothing else.

The experiment will not be repeated in the 1951–52 season as the possibility of commercial application is remote in an area where land is plentiful and shifting cultivation is the most practical system.

Pests and Diseases.

Blackarm (*Xanthomonas malvacearum*).—Commercial seed showed heavy primary infection which, coupled with a very wet season, resulted in one of the worst attacks of blackarm which had been experienced in the Nuba Mountains in many years. Waterlogged cotton which was at a standstill could not grow away. Growing points were frequently killed and infected sympodia which did not drop off carried bolls which were stained at the base of the loculus. The earliest cotton coming into the ginneries was small in quantity and badly stained by blackarm. The gene B_2 was insufficient to control the outbreak and a rapid bulking-up of a B_2B_3 type is clearly desirable. Figures in Table 7 refer to counts on four plots sown late (24th July, 1950) in order to encourage blackarm.

Table 7.
Average Blackarm Grade

Variety.	*9th September.*		*18th September.*	
	Row 10.	*Row* 15.	*Row* 10.	*Row* 15.
BAR SP84	4·3	5·5	5·9	5·3
BAR7/3	4·3	4·4	5·1	5·5
BAR7/8	2·4	2·1	2·3	2·4
PSS	5·0	6·1	6·2	6·1

The marked resistance of the B_2B_3 type BAR7/8 is demonstrated. 100 per cent. of plants scored were infected with the disease.

Bollworms.—Bollworm attack developed in August, being mainly Sudan bollworm, but during September American bollworm was more frequent. Egyptian bollworm was not common and by the end of November it was clear that pink bollworm attack was not going to develop on the scale of the season 1949–50. This marked reduction in pink bollworm can be attributed to the vigorous cutting-out campaign.

Cotton Leaf Roller (*Sylepta derogata*).—This appeared early in August and was locally severe. Handpicking controlled the pest on Kamina Farm but diverted much labour. It disappeared with the drier weather of October. Dusting with insecticides gave encouraging results.

Flea Beetle (*Podagrica puncticollis*).—The attack was heavy at sowing time and was controlled by DDT dust. Unlike the 1949–50 season, however, the pest did not persist.

Stainers (*Dysdercus fasciatus and D. superstitiosus*).—Throughout the Kadugli area the pest was of little importance. The spraying of the primary host (*Adansonia digitata*) seems to be an effective control. Outside the Kadugli area stainer attack has been more severe.

Other Crops.

Dura.—Four early, eleven mid-season and four late types were sown for production of pure nuclei. The " head-to-row " method was used as in previous seasons. Several larger bulks were also grown. All were affected by waterlogging, and secondary growth after the draining of the land resulted in two distinct crops.

Simsim (*Sesame indicum*).—Bulks of Kadugli Early Resistant White and Resistant White were grown. These types are resistant to Marad Ed Dam (*Bacterium sesame*) and gave seven times the yield of the ordinary susceptible red which was completely devastated. It is now suspected that a virus disease is involved in the reduction of yield ; specimens have been sent for identification. Further work to increase disease resistance and other qualities was continued including work on the red type.

Lubia helu (*Vigna unguiculata*).—Bulks of the three types Kadugli 3, 4 and 47 were grown. They have been described in the 1949–50 Report. The latter type was severely waterlogged, but the other two gave excellent yields and completely smothered all weed growth.

Groundnuts (*Arachis hypogea*).—Four small bulks of the varieties Barberton, Medani Erect, Abu Arbaa and American Erect were grown. The site being well drained, yields were excellent.

PROGRAMME FOR 1951-52.

Cotton Breeding Plots.—370 progeny rows of BAR NT96/40 for general type improvement and with a view to transferring the extra blackarm resistance conferred by the gene B_3 on the final improved type.

Cotton Variety Tests.—BAR SP84, BAR SP84.1, BAR SP84.2, BAR7/3, BAR7/8, BAR NT96/40 (ex Abdel Magid) and BAR7/8.1.

7 varieties × 7 replications.

At Gannaya 25 acres of BAR SP84 and 25 acres of BAR NT96/40 (ex Abdel Magid) for observation under native conditions.

Cotton Propagation.—1,000 acres of BAR7/8 on Abu Habl flood irrigation for general distribution.

1 acre of BAR7/8.1 on Abu Habl for further bulking and testing.

4 acres of Pump Scheme Strain at El Effein for type maintenance.

Weeding Experiment.—To demonstrate to cultivators the importance of weeding, especially in the early stages, and to obtain further proof of this point.

Other Crops.—Type maintenance and multiplication as before.

APPENDIX.

Key to Symbols used in this Report.

Varieties :—	
A332, A449, A455.	U4 × MU8 hybrids.
B31.	A blackarm resistant Upland type from Uganda.
BAR NT96/40.	NT96 carrying B_2 (American Upland).
BAR SP84.	The blackarm resistant component of Uganda SP84.
BAR SP84-1.	A first filter of BAR SP84 made by Rose.
BAR2/10.	NT2 carrying B_2.
BAR4/5.	9th backcross X1730 homozygous for B_2.
BAR4/7.	10th backcross X1730 homozygous for B_2.
BAR4/11.	X1730 homozygous for B_2 and B_3.
BAR4/16.	X1730 homozygous for B_2 and B_3.
BAR7/3.	Selection from BAR SP84 for improved G.O.T.
BAR7/8.	Blackarm resistant SP84 carrying B_2 and B_3.
BAR7/8.1.	A first filter of BAR7/8 made by Barlow.
BAR12/3.	5th backcross BP52 homozygous for B_2.
BAR14/1.	BAR2/10 × Domains Sakel[5] homozygous for B_2.
BAR14/7.	BAR2/10 × Domains Sakel[7] homozygous for B_2.
BLR14/16.	BAR14/7 reselected for leafcurl resistance.
BAR14/19.	6th backcross Domains Sakel homozygous for B_4.
BAR1730L (BAR XL, or XL).	7th backcross X1730A homozygous for B_2.
BAR1730L1 (BAR XL1, or XL1).	BAR1730L which has been " filtered."
DS.	A standard variety originally imported from Egypt.
DS1.	First " filter " of Domains Sakel made by Evelyn.

JR1530.	Selection from within 1530 for hairiness.
Pump Scheme Strain (PSS).	Commercial type which originated from Nyasaland Upland.
RDS.	A leafcurl resistant selection from Domains Sakel.
Wilds No. 11.	American Long Staple grown commercially at Zeidab. Large bolled early.
X1530.	A bushy variety selected by A. R. Lambert from Sakel.
X1730A (XA).	The successor type to X1730 at present grown commercially.
XL.	7th backcross X1730A homozygous for B_2.
XL1.	First filter of XL.
840, 841, 853, 857, 861, 862, 891.	Selections from BAR SP84 made by Rose.
Genes.	
B_1.	A dominant weak blackarm resistance factor from Uganda B31.
B_2.	A dominant strong blackarm resistance factor from Uganda B31.
B_3.	A strong partially dominant blackarm resistance factor from *punctatum*.
B_4.	A strong partially dominant blackarm resistance factor from *G. arboreum*.
B_5.	A blackarm resistance gene from " Grenadines White Pollen."
B_{6m}.	A blackarm resistance intensifier from *G. arboreum*.
B_7.	A blackarm resistance gene from Stoneville 20.
H_1.	A hairiness gene from Tanguis.
H_2.	A hairiness gene from *G. tomentosum*.

Received October, 1951.

NYASALAND.

SEASON 1950-51.

COTTON EXPERIMENT STATION.

BY

H. C. DUCKER.

Mr. W. L. Miller left on leave prior to retirement in June, 1951. He was succeeded as Farm Manager by Mr. R. Soar in October, 1951. Mr. S. H. Evelyn went on leave in July, 1951, and has since resigned.

District.	*Elevation feet a.s.l.*	*Types of Crop.*	*Months in which :*		*Legal Close Season.*
			Sown.	*Harvested.*	
All Cotton Areas of Southern and Central Provinces	*Approx.* 200 to 2,500	Summer	Dec.-Jan.	Jun.-Jul.	Aug.-Nov.
Northern Province	1,600	Winter	Apr.-Jun.	Oct.-Dec.	Jan.-Mar.

Government has decided to apply summer cropping practice to all cotton growing areas in the Southern Province, including the Lower River. This technique, developed by this Station and successfully applied in the Central Province, gives a fair measure of pest control and is an alternative, second-best, means of defeating the red bollworm, *Diparopsis castanea* Hmps. Though, ultimately, it is hoped that the Shire Valley and parts of the southern lake littoral may be irrigated, and the more efficient winter crop grown, this is not likely to come to pass for several years.

July 31st uprooting has been enforced in all summer crop areas in 1951. Seed issues will begin in October and be completed by December 1st. Pure stand plantings have been ordered, and there will be intensive propaganda for early and efficient weeding, for early thinning, and for early harvesting. Markets will be opened as soon as possible and the work of the buyers and ginners will be facilitated thereby. Rigid adherence to this régime will certainly result in better returns per unit area, and lint quality should be improved and rendered more consistent.

There was a shortfall of rain in the Lower River, and a small early crop from the first plantings with the virtual failure of late sown cotton on dry land has facilitated the July uprooting.

Conditions elsewhere in the Southern Province and in the Central Province were favourable to cotton and some satisfactory yields have been recorded, but enhanced prices and a drive to increase the area

sown have not yet had their full effect. There is usually a time lag of one full year in the African response to changed economic conditions. It is thought and hoped that acreages will be increased considerably in 1951–52, especially in the S.W. lake shore areas.

Karonga had a good crop in 1950, and 1951 sowings are reported to be doing well. Circumstances in the Northern Provinces remain unchanged.

The Station has had a good year with cotton and groundnuts, though the rains were rather too short for cereals to do well. Cotton seed stocks have made an excellent recovery, after the poor results in 1949–50, and the breeding programme has made progress. Yields averaging about 700 lb. seed cotton per acre were obtained, with some 90% clean and white. Rainfall in inches, for the months October, 1950, to September, 1951, is shown below.

Oct.	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May.*	*Jun.*	*Jul.*	*Aug.*	*Sept.*	*Total.*
0·14	1·85	5·18	6·99	12·10	2·36	0·77	0·09	—	0·08	0·25	—	29·81

The Government Farm at Kalambe grew approximately 70 acres of CL20 mixed bulk which gave the very fair yield of over 500 lb. seed cotton per acre in spite of poorish stands, resulting from the low quality of 1949–50 Station seed.

Mechanisation.

More satisfactory results were obtained with the tractor and implements this season, partly owing to dry weather in March which allowed ploughing to be done under softer soil conditions. The break returning to cultivation from " grass rest " was all ploughed before the land had dried out and an excellent tilth has resulted. An experiment in " stetch " ploughing on the contour, done in a 5 acre field at the break of the rains, was most successful. Using a three-furrow mouldboard plough, one cut up-hill was made in one direction and one cut down-hill in the other. Maize, sown at 6 ft. × 2 ft. on the large ridges so made, did well considering the site and season, and pigeon peas, interplanted at the same time on either side of the maize rows, have made an excellent cover. The field used had washed badly in 1949–50, but erosion on it has now been effectively checked.

A small field heavily infested with " dub " grass (*Cynodon dactylon*) has been ploughed and cross-ploughed with a five-furrow disc plough. A good kill of the weed seems to have resulted and the tilth is excellent.

There is still, however, much to be learned about local problems of mechanised farming, and the economic aspects need careful study. An outstanding need is for an efficient disc ridger, capable of tackling land too hard for the ordinary mouldboard pattern.

Cotton.

Bulks were grown of the CL20-20 mixture made from the best selections of this strain (now called CL20 for short), of the best commercial stock from the Lower River, Ngabu CLB, and of the Northern Province commercial stock, Karonga CLB. From them were taken a large number of single plant selections, and the "filtering" technique, for major yield characteristics, has been applied. The following table shows the mean figures of the material retained for planting in progeny lots this coming season, and includes those of specially marked blackarm resistant plants of CL20.

All weights in grams.

Means.	*Wt. Seed Cotton per plant.*	*Wt. Seed Cotton per boll.*	*Wt. Lint per boll.*	*Wt. 100 Seeds.*	*Lint Index.*	*Ginning %*
CL20 Mixed Bulk ...	146	4·9	1·72	10·4	5·5	34·6
BAR CL20	147	4·9	1·70	10·8	5·6	34·3
Ngabu CLB	90·5	4·8	1·71	10·5	5·8	35·4
Karonga CLB ...	86·3	5·2	1·88	11·5	6·5	36·0

A much higher standard of yield per plant was set for the CL20 lots than for the CLB material since, while the former was wide-spaced in a poorish stand, the latter was in normal spacings of 3 ft. × 2 ft, three plants per hole, in good stands. Lint lengths were measured and notes taken on quality, an attempt being made to maintain the usual Nyasaland standard approved by the trade.

All three stocks were compared in a standard strain trial. There was no difference in yielding power between the two CLB lots, and the poorer showing of CL20 can be explained by its much poorer stands. 1949–50 seed grown at the Station suffered from the inclement season and was of low germinability. Exactly comparable lots of all three strains will be used in further trials at the Station and at Makanga in the Lower River, this coming season. Results of the 1950–51 trial are given below.

Yields in lb. Lint per acre.

CL20	*Karonga CLB.*	*Ngabu CLB.*	*Sig. Diff.* (P = 0·05)	*S.E.*
200	320	327	15·4	5·2

At the suggestion of Mr. H. L. Manning, Namulonge, a simple fertiliser experiment, to test the effect of nitrogen at two levels, was laid out in part of the Karonga CLB bulk planting. The dressings were 100 lb. and 200 lb. per acre of ammonium sulphate, and were applied on February 1st, about the middle of the rains and about three weeks before flowering began in earnest. Results were as follows :

Yields in lb. Lint per acre.

Control No Fertiliser	n_1	n_2	*Sig. Diff.* (P = 0·05)	*S.E.*
239	257	285	22·2	7·1

Evidently, over the range of treatments tested, response to nitrogen was proportional to dosage.

Seed stocks of Albar, a high blackarm resistance cotton, probably a cross of Nigerian Allen and *G. punctatum*, were supplied by Namulonge, both Shambat and Namulonge strains being provided by Dr. J. B. Hutchinson. These grew well and though at one stage it looked as if they might be insufficiently jassid resistant, their hirsuteness appeared to improve with age. A moderate amount of sterility was noted, but there was plenty of fertile pollen and a series of locally made crosses, of both Albars and the best available CL20 lots, is now under way.

In addition Dr. Hutchinson kindly supplied the Station with seed of a cross (Albar × BP52) × CL20 homozygous for B_3. Twenty plants were grown and showed enormous vigour and high individual yields. They should be valuable material for future study.

Mr. A. H. McKinstry, of the Gatooma Cotton Research Station, Southern Rhodesia, kindly supplied seed of four crosses, MU8 × $BP52^3$, originally made at Barberton by Mr. F. R. Parnell. They yielded very heavily in normal spacing, the low seed rate of two seeds per hole being used, and there is ample material for further study.

The small collection of varieties which has been maintained at the Station was replanted in small plots to provide replacement seed stocks and satisfactory pickings were obtained.

Blackarm.—There was a heavy initial attack of this disease with much primary infection on plants grown from 1949–50 Station seed. During the dryish weather in March the disease died away and even heavily infected plants made a good recovery. The fact that Karonga CLB, grown from seed obtained from a winter or rainless crop, showed no primary infection, is of interest. It emphasises the necessity for equalised infection of planting material used in strain or variety trials.

Food Crops.

Maize.—It was a poor year for cereals generally and maize in particular at the Station. Sixty acres of bulk maize yielded only 360 lb. grain per acre. The best yield of bulk was obtained from a short-term yellow maize planted on the " stetch " ploughed land and in the rotation experiment. This gave 680 lb. grain per acre. A variety trial, carried out in co-operation with the Government Research Station at Lilongwe, gave rather inconclusive results, locally selected native bulk doing best. Southern Rhodesia hybrid types did quite well but were not particularly outstanding. A large fertiliser trial, also carried out in co-operation with the Government Station, covered N, P, and K dressings at various levels and various times of application. Locally selected native bulk maize was sown in this trial. There was a

clear response to nitrogen, whether applied at germination or at flowering or both, but the other elements were without effect. A similar result was noted at the Government Farm, Kalambe, some three miles from the Station, where another similar experiment was laid down.

Sorghum.—Twenty-five acres were drilled with local bulk sorghum using a converted mule-draft planter and the tractor, no suitable planter designed for tractor draft being available. A good stand was obtained and since the sorghum is being used as a nurse crop for natural grasses in land due to rest, no inter-cultivation was done. The seed rate used, 13 lb. per acre, proved rather too high, and inter-plant competition, plus weed effect, resulted in the low mean yield of approximately 500 lb. grain per acre. An attempt at thinning part of the area had no effect on final yield, and was probably done too late.

While better than maize, the sorghum yield is hardly good enough and next season more attention will be paid to weeding and a lower seed rate will be used. The standover or ratoon sorghum will, however, continue to remain unweeded, since so treated it appears to provide the right conditions for establishing a grass rest.

The collection of sorghum varieties was maintained. In general the medium to long term types do best at the Station and in Nyasaland as a whole. Short term types, which ripen their grain before the rains have ceased, offer storage difficulties and do not suit the African. An attempt to introduce such types to him in the 1930's was unsuccessful, and there is a history of short term sorghum varieties which have died out in the Lower River.

Groundnuts.—Excellent yields were obtained from some 27 acres of bulk groundnuts. Half the area was planted to the early Gambia Bunch and gave 1,514 lb. unshelled nuts per acre. The balance was sown with Mwitunde, a late maturing bunch type from Tanganyika, which gave 1,211 lb. per acre. This planting of partly an early, partly a late form enables harvesting to be staggered and is an insurance against seasonal fluctuations. In the summer crop cotton areas groundnuts are far the best and safest pulse crop and they are most satisfactory as a rotation with cotton.

On the balance of the groundnut acreage the collection of varieties was planted, for the most part in duplicate plots. In general the varieties lie within the range of yielding power defined by the two main varieties mentioned above.

Husbandry.

A long term rotation experiment, which reached its penultimate year this season, gave high yields of cotton, groundnuts and maize for land which has had five years of continuous cropping and which was cleared from bush 22 years ago. The treatment effects will be tested next season with maize sown in all plots.

No new experiments have been begun, and rest cropping studies are being confined for the present to observations in the field on the effects of current practice. Roughly half the Station is in rest, half under crop in any one year, and elephant grass has been abandoned in favour of local grasses, especially *Urochloa* and *Hyparrhenia* spp. which establish themselves very well by self-seeding from uncultivated strips in the fields and from the field margins.

The use of sorghum as a means of introducing a grass rest is a valuable practice in several ways, and it is to be hoped that ratooning will not lead to uncontrollable pest or disease attacks. The sorghum itself provides a valuable ground cover, and though when treated as an annual this crop is definitely exhaustive, such does not appear to be true of it as a quasi-perennial. It is, after all, a grass itself and has a most powerful root system which should have structure building capabilities on heavy soils in this monsoon climate. The re-establishment of local grasses, herbs, and shrubs proceeds smoothly under its cover. From the point of view of grain production the seeding year and the first ratoon are the most important, and ratoon sorghum proved particularly valuable in the drought of 1948–49. It was about the only cereal which gave any crop at all on the dry lands of this area in that season.

PROGRAMME FOR 1951-52

Work will continue on similar lines to that of the year just ended. It has been decided to recommence outside cotton trials now that the importance of comparable seed lots with equalised blackarm infection has been realised, and a replicate of the main station variety trial has been arranged at Makanga in the Lower River. It is hoped to conduct some statistical trials with sorghum and groundnuts, and to extend rest crop studies. Further experiments will be made with power cultivation, but it is not intended that hand cultivation should be neglected in husbandry studies.

Received August, 1951.

[Included by courtesy of the Southern Rhodesia Government.]

SOUTHERN RHODESIA.

COTTON RESEARCH STATION, GATOOMA.
PROGRESS REPORT FOR THE SEASON 1950-51.

BY

A. H. McKINSTRY AND R. W. JAMES.

Planting Period	13th-21st November, 1950.
Germination	During week ending 9th December, 1950.
Flowering	Commencing first week of February, and mainly February, 1951.
Picking	May and June 1951.
Legal Uprooting Date	30th September, 1951.

METEOROLOGY.

The total rainfall for the season was 22·26 inches. This was badly distributed, and long periods of drought were experienced during the flowering period.

Although two inches were recorded in early November, the seed was planted in dry soil and it did not germinate until the first week in December. Half the season's total rainfall was recorded in December. This was followed by scattered, sub-normal rainfall in January, practically negligible rainfall in February, and erratic rainfall in March.

GENETICS AND BREEDING.

As spinning and other tests performed last season had shown the MU8A × BP52[2] strains received from Barberton to be a definite advance on U4 strains both for lint quality and for other characters, tentative plans had been made to issue A5851 in 1951–52 for commercial bulking. This project has had to be abandoned as these strains have shown themselves to be particularly susceptible to blackarm. Thus blackarm is now the main limiting factor in breeding strains with better quality lint, derived from MU8A × BP52[2].

Blackarm grading was not possible this season, as no strains of known genetic constitution for blackarm resistance were available. However, strains which are homozygous for B_2 and B_2B_3, and others which are susceptible, have now been received from Dr. R. L. Knight, and a start will be made to establish a scale of grades for blackarm resistance for local conditions in the coming season.

Main Strain Trial.—Twenty-five strains were compared in a 5 × 5 lattice square design with three replications, in plots of 0·0064 hectare at 1 m. × 20 cms. spacing. The seed germinated during the week ending 9th December, 1950.

Table 1.

Summary of Results of Main Strain Trial, 1950–51.

	Yield Lint lb/acre.	*Ginning %*	*Lint Index.*
9L34	78	31·3	3·38
Mean of 8 7C Strains	73	33·5	4·26
Mean of 8 U4 Strains	66	31·8	4·03
Mean of 8 MU8A × BP52[2]	48	34·9	4·74
S.E.	±10·2	±0·74	±0·256
Sig. Diff. at P = 0·05	30	1·2	0·85

In comparison with last year's results it will be noticed that the MU8A × BP52[2] strains have moved from near the top of the Table to the bottom for yield of lint per acre. This was mainly due to blackarm.

The Modal Bulks formed last season from the Barberton strains A5851, A616, etc., were so badly affected by blackarm that it was impossible to obtain sufficient seed cotton from single plants for analysis.

Crosses.—A number of crosses were made between MU8A and other strains, but in view of more recent information about blackarm resistance, obtained from Namulonge, the hybridisation programme has been reorganised.

Agriculture.

Fertiliser Experiments.—Two 3 × 3 × 3 factorial experiments were laid out, each comparing three levels (0, 250 and 500 lb. per acre) of nitrogen, superphosphate, and potash fertilisers. Plot size was in each case 0·005 hectare. In the first trial, nitrate of soda, superphosphate and muriate of potash were compared in 12 blocks of 9 plots each. In the second, sulphate of ammonia, superphosphate and sulphate of potash were compared in 6 blocks of 9 plots each.

The fertilisers were placed on one side of each row, in a position $2\frac{1}{2}$″ to the side of and 3″ below the seed level at planting. The experiments were planted dry on 16th November, 1950, and germinated during the week ending 9th December, 1950. The spacing used was 1 m. × 20 cm. The strain used was the commercial 9L34.

YIELD OF SEED COTTON IN LB. PER ACRE ; NITRATE OF SODA, SUPERPHOSPHATE AND MURIATE OF POTASH TRIAL.

Mean Yields : n_0 420 p_0 303 k_0 406
n_1 435 p_1 481 k_1 447
n_2 439 p_2 511 k_2 441

S.E. ±11·3

Sig. Diff. at P = 0·05 = 32 lb. per acre.

3 × 3 *Table :*

	p_0	p_1	p_2		k_0	k_1	k_2		k_0	k_1	k_2
n_0	316	465	479	n_0	391	442	428	p_0	278	307	322
n_1	304	485	517	n_1	400	444	462	p_1	463	493	486
n_2	288	491	537	n_2	425	457	434	p_2	476	542	515

S.E. ±19·6

Sig. Diff. at P = 0·05 = 55 lb. per acre.

YIELD OF SEED COTTON IN LB. PER ACRE ; SULPHATE OF AMMONIA SUPERPHOSPHATE AND SULPHATE OF POTASH TRIAL.

Mean Yields : n_0 562 p_0 386 k_0 468
n_1 548 p_1 593 k_1 576
n_2 486 p_2 618 k_2 553

S.E. ±20·5

Sig. Diff. at P = 0·05 = 60 lb. per acre.

3 × 3 *Table :*

	p_0	p_1	p_2		k_0	k_1	k_2		k_0	k_1	k_2
n_0	431	538	718	n_0	514	563	610	p_0	342	395	422
n_1	401	647	596	n_1	518	577	550	p_1	516	668	594
n_2	326	593	540	n_2	371	590	498	p_2	546	666	642

S.E. ±35·5

Sig. Diff. at P = 0·05 = 104 lb. per acre.

Soil Analysis.—A soil analysis from the site of these experiments gave the following results :

Texture	Brownish red clay.
% Moisture	3·8
Further Loss on Ignition	9·5
% Nitrogen	0·13 (high)
Available Minerals (approx.)	
Calcium (mg. eq. %)	15·0 (high)
Magnesium (mg. eq. %)	6·8 (high)
Phosphate (mgm. % of P_2O_5)	3·0 (low)
Potassium (mgm. eq. %)	0·20 (low)
pH	6·3

In both of these experiments there was a highly significant response to the application of superphosphate. Potash gave a significant response in both experiments. Nitrate nitrogen gave a small, but non-significant, increase in experiment No. 1, and ammonium nitrogen gave a significant decrease in yield in No. 2. It is thought that the latter result was due to the toxic effect of a high concentration of ammonium ions. The area of contact of fertiliser with the soil was probably too small, when band-placed in a dry season, to allow the nitrifying bacteria to change the ammonium form to the available nitrate form at the time when the plant required nitrogen. Experiments for the coming season have therefore been planned to include tests of different times and methods of application of the two nitrogenous fertilisers.

These experiments have shown that cotton yields can be greatly increased by the application of placed artificial fertiliser and that at the present fertiliser and seed cotton prices it is an economic proposition. Although no definite recommendations can be made to farmers at present, a number are planting observation plots this coming season and sufficient evidence should be available in the next two or three years.

Mechanical Picking.

1949/50 *Results.*—As mentioned in last year's Progress Report, cotton was harvested by an I.H.C. spindle-type high-drum picker from about 25 acres of 9L34. This acreage embraced 6 plots, ranging in size from 0·5 to 9 acres. The mean yield per acre was 475 lb. of "Picker Class" seed cotton. The following is a percentage analysis of the "Picker Class" seed cotton harvested.

1. Seed cotton picked by picker 73%
2. Seed cotton remaining after operation of picker : (*a*) on the plants ... 13%
   (*b*) on the ground ... 14%

The losses obtained on ginning, cleaning, and carding the mechanically picked cotton are compared with the normal average losses for Rhodesian hand-picked Class 1 seed cotton in Table 2. It must be noted that the ginnery is not equipped with pre-ginning cleaning machinery.

Table 2.

A Comparison of Cleaning Losses between Mechanically-picked and Hand-picked Seed Cotton.

Machinery.	*Percentage Losses : Strain 9L34.*	
	Mechanically-picked Cotton.	*Rhodesian Class 1 Hand-picked Cotton.*
Ginnery	7	4
Blowroom	16·75	2·75
Card	6	4·5
Totals	29·75	11·25

The comparison shows that in the processes of ginning and cleaning 9L34 mechanically-picked cotton gives 18·5% greater loss than Class 1 hand-picked seed cotton. The greater loss is due largely to different forms of dirt in mechanically-picked cotton.

The yarn spun from the mechanically-picked lint was of a pronounced creamy colour, and slightly more neppy than that of Class 1 lint.

1950–51 *Results.*—During this season a comparison was made between 9L34 and 42204 for suitability for mechanical picking. The habit of 42204, a 7C derivative, appeared to be more suited to mechanical picking, although the lint of this strain is shorter than the standard required by the mills. The strains were planted in alternate strips of four rows. These were about 300 yards long, and

the total acreage of each strain was 1·4 acres. The mean yield of the 42204 plots was 428 lb. picker class seed cotton per acre, and that of the 9L34 plots was 337 lb. picker class seed cotton per acre. The picker harvested 82% of the 42204 crop and 73% of the 9L34 crop, a difference of 9% in favour of 42204. In another comparison between 9L34 and selections taken in 1948–49 from 42204, the picker harvested 17% more seed cotton from certain of the 42204 selections. It is apparent, therefore, that 42204 material contains suitable mechanical picker type strains.

Small scale comparisons between the defoliants Ammonium Thiocyanate and FR/9, which contains sodium chlorate and which is probably closely allied to the " Shed-a-Leaf " Defoliant, demonstrated the superiority of FR/9. Further tests will be done in the coming season with FR/9.

Cotton Pests.

Records of plant and insect development, taken over many years, show that the larger part of the cotton crop is derived from the first six weeks of flowering, and that during this period attacks and damage by the major pests of the crop are of great importance. The records indicate the seasonal incidence and relative importance of the different pests.

Using these records as a basis, an experiment was planned in co-operation with Messrs. Pest Control (Central Africa) Ltd., to apply certain insecticides, at approximately fortnightly intervals, over a period of 4 to 6 weeks, commencing early in the flowering cycle.

The main object of the experiment was to examine the effect of 16 insecticidal treatments on the development of Sudan, American and spiny bollworms, cotton stainers, and aphis. Comprehensive records were taken on the different insect pest populations, on flowering, and on the shedding of buds and bolls weekly.

The whole experiment occupied approximately 12 acres and formed part of a 43 acre field of cotton. The size of each plot was six rows, spaced 1m. apart × 50 m. in length. The spacing between plants in the row was 20 cm.

Treatments, of which there were 17 inclusive of the control, were arranged in four randomised blocks. The 17 treatments were alternated with 18 untreated plots in each block, resulting in a total of 35 plots per block. The 18 systematically arranged plots were excluded from the analysis. The arrangement probably favoured a uniform dispersion of insect pest populations throughout the area, and it minimised the drift of insecticides between treatments.

The insecticidal treatments and their rates of application per acre, on each occasion, were as follows :

2 lb. technical Toxaphene as miscible oil.
2·5 lb. technical DDT as emulsion liquid.
4 lb. of a wettable powder mixture containing 50% DDT and 12% Parathion.
Pestox 3 at a strength of 0·33% of the active ingredient.

The Pestox 3 was mixed either with DDT or Toxaphene on one of the occasions of application, but only in certain treatments. In others, either DDT or Toxaphene was applied alone. The insecticides were applied as sprays at the rate of 60 to 70 gallons per acre through hand-guns supplied with the liquids by a tractor-operated hydralux pump. Applications were made on 7th–8th February, and again on 22nd February as planned, but rainfall and other factors first interrupted and then delayed the third application. Treatments which were applied on the 12th and 29th March should all have been applied about the 8th of March.

The main deductions from the records and observations on insect populations, plant development, and yield data are as follows:

1. The seed germinated during the week ending 9th December, 1950. The plants started to flower during the first week of February, but effective flowering did not occur for longer than about four weeks. It was restricted mainly by drought conditions. Because of the drought, and to a certain degree because of below-par soil fertility, yields were of a low order.

2. The salient features of the attacks by the different insect pests may be summarised as follows : American bollworm attack was well defined, but moderate in intensity ; Sudan attack was persistent and heavy throughout the season ; spiny bollworm larvae were more numerous than usual ; aphis infestation was marked during the main flowering period ; cotton stainer populations were very small.

3. None of the insecticidal treatments had any effect in reducing either Sudan or spiny bollworm larval populations, for all practical purposes.

4. The value of treatments in reducing stainer populations cannot be assessed owing to the small numbers of this pest.

5. Two applications of DDT, one applied at the very start of the flowering and the other a fortnight later, reduced American bollworm populations considerably. Similar applications of Toxaphene also reduced American bollworm larval numbers but not to the same extent as DDT.

6. The systemic insecticide Pestox 3 was effective in controlling aphid populations for a period of four to five weeks after application.

7. From the yield results given in Table 3 it is noteworthy that all treatments which contained Pestox 3, whether in combination with DDT or with Toxaphene, gave the highest yields.

TABLE 3.

1950–51 INSECTICIDES TRIAL WITH COTTON.

P3 = Pestox 3 ; T = Toxaphene ; DDT/P = DDT and Parathion.

Treatment and Dates of Application				*Yield of Seed Cotton lb/acre.*	*Percentage of Control.*
February 7–8th.	*February 22nd.*	*March 12th.*	*March 29th.*		
DDT	DDT/P3	DDT	DDT	263	227
T	T/P3	Nil	Nil	233	201
DDT	DDT/P3	Nil	Nil	220	189
Nil	DDT/P3	Nil	Nil	214	185
T	T/P3	Nil	T	197	170
Nil	Nil	DDT	DDT	195	168
DDT/P	DDT/P	Nil	Nil	188	162
DDT/P	Nil	Nil	Nil	187	162
T	Nil	Nil	Nil	184	158
T	Nil	Nil	T	162	139
DDT/P	DDT/P	Nil	DDT/P	155	134
Nil	Nil	Nil	DDT/P	147	127
DDT/P	Nil	Nil	DDT/P	143	123
DDT	Nil	DDT	DDT	129	112
DDT	Nil	Nil	Nil	123	106
Nil	Nil	Nil	Nil	116	100
Nil	Nil	Nil	T	113	98
Standard Error ±				21·7	18·7
Significant Difference at P = 0·05				62	53

Received October, 1951.

NORTHERN NIGERIA.

PROGRESS REPORT FOR THE SEASON 1950-51

BY
H. E. KING.

Planting Period	June to August
Picking Period	November to February
Close Season	April to early June*
Rainfall at Samaru (April-October 1950)	35.4 inches
(Annual average for 25 previous seasons	44.1 inches)

Introductory.

Season.

An export crop of 75,054 bales was obtained from a seed issue of 9,475 tons. Both these figures are records for Northern Nigeria, but the increase in production over last season's figure of 57,507 bales is little more than a reflection of the increase in seed issue and does not indicate a particularly favourable season.

The weather was in fact only moderately favourable, with an early and abrupt cessation of the rains in most districts.

Notable features of the season at Samaru were the below average temperatures throughout much of the period July to September, the late appearance of *Xanthomonas malvacearum* symptoms, the strong vegetative growth, heavy flowering, extremely heavy boll shedding and the relatively high yields obtained.

This heavy shedding, which also attained alarming proportions at Daudawa and throughout Southern Katsina, was not clearly attributable to particularly heavy insect attack or to disease. Boll-worm damage was in fact comparatively light and " blackarm ", although present, was far less in evidence than last season. The bolls shed represented only a proportion of the extra potential crop resulting from the strong growth and heavy flowering, and yields at Samaru were above those of last season when shedding was less heavy.

At Daudawa also, yields were good, and the production of seed of Samaru 26C throughout the multiplication scheme exceeded the estimates and enabled the acreages planned for the following season to be stepped up. This result can be attributed largely to the greater supervision exercised over the scheme, to the issues of superphosphate and to the intensified propaganda in favour of earlier planting and better cultivation. The seed produced has enabled over 115,000 acres (viz., the whole of the Funtua ginnery area) to be planted with 26C in 1951–52 season.

* There is still no single rigidly defined close season throughout Northern Nigeria but progress has been made in establishing local cutting-out dates with penalties for non-observance.

Staff, Buildings and Organization.

Mr. Q. A. Geering left Samaru on transfer to Uganda in January, 1951, and Mr. A. F. H. Baillie, who was posted to Samaru in the previous September, then took over responsibility for the entomological work. Mr. H. E. King went on leave in early February leaving the remainder of the season's routine work on the plant breeding side to be carried out by the Nigerian staff under the general supervision of Mr. A. R. Maurer, the Government Botanist.

With the completion of an extension to the botanical laboratories much improved accommodation became available for the plant breeding staff and near the end of the season a new laboratory building and insectary for the entomologist was commenced.

Owing to the shortage throughout the agricultural department of trained Nigerian assistants of the standard necessary for scientific work it was not possible to obtain any effective additions to the local staff this season.

Several acres of new land were brought under cotton experiments at Samaru and a further area cleared for future use.

In contrast to the disappointing first crop on new land mentioned in last season's report, the new area used this season, which was cleared and broken up at the end of the previous rains, gave very good yields indeed on local standards.

Plant Breeding.

Breeding and Selection Work.

All the plantings of breeding material grew well and yielded much promising material. In particular, a replicated progeny row test containing 128 progenies of 26C derivation was most successful.

This experiment, which comprised seven replications and included controls of bulk 26C, totalled 952 plots of 1/800th acre net area. It gave very high yields and highly significant yield differences between families and also between progenies within families in a number of cases.

The full results, which included numerical scores for insect damage as well as ginning percentages, lint lengths, etc., are far too voluminous for presentation here but showed clearly that the very considerable work entailed was amply repaid by the confidence with which it was possible to pick out some derivatives worth immediate extended trial and others likely to respond to further selection work.

The average yield of the 26C controls was 933 lb. of seed cotton per acre while the best single progeny gave the striking figure of 1,335 lb. and the best family averaged 1,127 lb.

These extremely high yields (by Nigerian standards) are perhaps unduly inflated by the use of such very small plots, being calculated on

net area, and the observed increases over the control may also be unrepresentative of what would be obtained in larger tests, though differences in vegetative vigour were not such as to suggest marked competition effects.

There was a tendency for the progenies which gave the highest yields of seed cotton to be those with rather lower ginning percentages, but an increase of 33 per cent. in lint yield over 26C was given by one progeny with several others closely approaching this and the best family averaging an 11 per cent. increase.

Lint lengths and other characters under observation were in general satisfactory, though variable. Significant differences were present in both field and laboratory observations. In particular, there were quite wide and significant differences in the degree of leaf fretting ascribed to *Campylomma* and in the vigour of early growth of seedlings.

Production of New Nucleus Stock of Samaru 26C.

A new stock of seed for issue to Daudawa for sowing as Stage O in the 1951–52 season was made up by a process designed to give a purified bulk, of substantially unchanged intrinsic character but reduced variability, in the shortest possible time. The method used is outlined below. It combines features of three different plant breeding techniques, namely the " Replicated Progeny Row Test " advocated by Hutchinson and Panse, the " Mass Pedigree System " used by Harland in Peru and the " filtering " or " modal bulk " technique used in the Sudan and Uganda.

The first step (carried out in the 1949–50 season) was to select, from an area sown with the best existing stock of 26C, a large number of typical well-grown fruitful plants and to bring in their produce, keeping that of each plant separate, for laboratory examination. From these, all plants of which the values for ginning percentage, seed weight and lint length were outside certain limits were rejected (or, if the divergence was in an upward direction, set on one side for separate tests). These limits were set on either side of the mean value, but a bigger divergence was allowed in an upward than in a downward direction, particularly in the case of lint length, and the limits for one character were not applied rigidly without reference to the level of others.

Of 300 plants brought in about half survived this " screening " process. A considerable number of the rejections were plants showing a combination of short lint and high ginning percentage, but the mean ginning percentage of plants surviving was maintained by the rejection of an appropriate number with low ginning percentage. The ranges within one group of 200 plants, before undergoing this screening, were given in the 1949–50 Progress Report (p. 94).

The next step, carried out in 1950–51, was to carry forward seed of the chosen plants, still keeping each separate, to a replicated progeny

row test. One hundred and forty-four progenies were grown, each with four replications of approximately 1/800th acre each. Examination in the field enabled 17 progenies to be rejected for jassid susceptibility or undesirable habit of growth. An early first picking of the remainder was then taken for rapid laboratory determinations of lint length, ginning percentage and seed weight using composite samples from the four replicates.

With the data so obtained, a second screening was then carried out, based this time on progeny means. The variation shown by these was much less than that displayed by the 200 single plants in the previous season and much narrower limits could be set up. These were adjusted to retain about half the progenies, this being the number estimated as necessary to provide the seed needed. The actual number of progenies surviving this second screening was 66 and subsequent pickings of these, bulked together, yielded over 200 lb. of seed, sufficient for a 20 acre multiplication area.

Although only four replications were grown, the yield data were analysed statistically and the presence of significant differences between progenies was demonstrated. The plot to plot variation in yield was very great but the lattice design employed eliminated a substantial part of this from the progeny comparisons and gave a gain in efficiency of 33 per cent. compared with randomized blocks and a standard error for comparisons of progenies equal to 11 per cent. of the mean. The extreme range between highest and lowest yielding progeny was 60 per cent. of the mean yield of all.

The majority of the progenies noted in the field for rejection without laboratory tests gave less than the average yield but, apart from these and four others later rejected out of hand for poor early picking, no account was taken of the seed cotton yields in the screening process. The yields averaged for the two classes were as follows :—

Mean S.C. yield of 66 accepted progenies : 886 lb. per acre.
" " " " 57 rejected " : 873 " " "

It appears therefore that the progenies found acceptable for lint length, ginning percentage and seed weight were on average as high yielding as those rejected, and that the bulk made up from the 66 accepted progenies should not be inferior in seed cotton yield to the original bulk 26C stock.

Seventeen of the accepted progenies and 12 of the rejected were later chosen for inclusion in replicated tests. These included the highest yielding irrespective of other characters, as well as some of exceptional lint length and ginning percentage.

Replicated Trial of Seed Stocks.

Five seed stocks of Samaru 26C and three of Commercial Allen were included in tests at Samaru and Daudawa. The results of the Samaru trial are summarized below. There were 16 replications

arranged in lattice squares in plots of 1/150th acre, two plants per hole at 3 ft. × 1½ ft. spacing sown 6th July on Botanist's Farm. Results are shown in Table 1.

Table 1.

Seed Stock.	Stand %	Lint Yield lb. per acre.	Ginning Percentage.
Samaru 26C Seed			
Heavily Rogued Nucleus	97·4	299	35·3
Produce of Daudawa Stage 0	90·7	256	34·9
,, ,, ,, 1	95·2	273	34·7
,, ,, ,, 2	95·2	261	34·4
,, ,, ,, 3	95·0	254	34·1
Commercial Allen Seed.			
From Funtua	94·0	232	32·8
From Zaria	94·3	225	32·2
From Wase	94·0	236	32·3
Standard Error	—	5·7	—

The mean yield of the four Daudawa stocks was 261 lb. against 231 lb. for the three Allen stocks, giving 26C an advantage of 13 per cent. A little over half this was due to the higher ginning percentage. On seed cotton yields 26C gave 6 per cent. more than Allen.

The heavily rogued nucleus stock is omitted from these average figures for 26C. This was the produce of a plot sown at Samaru with the same seed as that used for sowing Daudawa Stage O. This Samaru plot was subjected to very heavy roguing. The removal of about 7 per cent. of inferior plants, chiefly for lack of jassid resistance, is unlikely to have given rise to the marked increase in yield shown by the produce. It is probable that in part at least this was due to the fact that the seed was better developed than that of the Daudawa produce, thus giving discernibly better early growth as well as a slightly higher stand figure. In a trial of this nature differences due to the conditions under which the seed was produced are only to be expected, so that, in spite of the high accuracy given by the use of 16 replications, very close comparisons of individual stocks are not possible. The Stage O seed used was of poor viability and may have been supplied from a late picking.

There is no indication of real differences between the various Daudawa stages in yield, though the consistent small drops in ginning percentage from Stage O to Stage 3 are suggestive of progressive contamination with Allen.

The stocks of "Allen" from three localities gave surprisingly similar yields and ginning percentages. It is not improbable that all three represent the produce of Allen stocks "graded up" by past issues of improved seed of which full trace has not been kept. This seems now the most plausible explanation of the difference of only 2 per cent. between the ginning percentages of 26C and "Allen" noted last season and now recorded again.

The corresponding trial of these stocks at Daudawa with only eight replications was a failure. Growth and yields were poor and extremely

irregular, apparently as a result of water-logging on a naturally poor and irregular soil. The coefficient of variation reached the abnormally high value of 29 per cent. and the recorded yield differences between seed stocks were totally meaningless, though the ginning percentages supported those recorded at Samaru.

District Variety Tests.

A series of five tests was laid down, each of the same eight strains replicated seven times in a balanced incomplete block design. The plot size was approximately 1/80th acre, with two plants per hole, spaced 3 ft. × 1½ ft. The sites were Kano, Gusau, Samaru, Kontagora and Zonkwa, covering a range in mean annual rainfall from 33 in. (Kano) to 58 in. (Zonkwa).

The results differed rather widely in accuracy from site to site. At Samaru, stands were quite good and reasonably comparable for each strain, but at other sites, under more difficult conditions, stands were lower and differed significantly between strains. At Kano in particular, inadequate moisture at planting resulted in an average stand of no more than 60 per cent., while at Zonkwa there were wide differences about a mean of 71 per cent.

In these circumstances it appeared unprofitable to combine all the results although, apart from stand, there was no clear indication of interaction of strain with locality. Results of the three most informative experiments are given in Table 2.

Table 2.
Stands and Yields of Three District Variety Tests.

Strain.	Gusau. Stand %	Gusau. Lb. lint p.a.	Samaru. Stand %	Samaru. Lb. lint p.a.	Kontagora. Stand %	Kontagora. Lb. lint p.a.	Mean Lint Yield as %
26C	87	164	93	220	77	59	100
26C/4721	83	176	90	246	71	60	109
26C/4724	81	190	91	240	82	55	110
26C/4736	86	169	95	221	82	45	98
MU8	73	189	89	258	79	57	114
MU8 × BP52	85	131	93	218	79	47	89
MU8 × U4	84	122	92	216	76	40	85
Uk48	84	135	92	175	77	53	82
S.E.	—	15·8	—	7·3	—	5·1	—

The yields of 26C at each site reflect the general differences between the localities. For Kano and Zonkwa (not given above) they were 160 and 123 lb. of lint per acre respectively. The low yield at Kontagora reflects heavier insect infestation and poor soil. The relatively poor showing of MU8 at Kontagora is perhaps the only figure suggestive of differential varietal reaction to locality. At Samaru and Gusau it gave a clear increase over 26C, as in previous tests at Samaru. The two hybrids having MU8 as one parent and better lint quality have hardly done well enough in lint yield to merit further trial. This is largely a result of lower ginning percentages (approx. 3 per cent. below 26C). The Tanganyika type Uk48 also

failed on account of this character, being 4 per cent. down after looking attractive in growth and giving seed cotton yields little below 26C.

Subsidiary Varietal Test at Samaru.

Results from this experiment (a balanced lattice design with nine small bulks replicated eight times) gave useful indications of the relative merit of some further types. BAR12/3, a blackarm resistant derivative of BP52 referred to in the last report, failed to approach the yield of 26C. This again was on account of far lower ginning percentage. A bulking of selections from BAR D28 gave indications that this type is worth continued attention. Two small bulks made up from single plant selections taken from bulk Allen gave an interesting contrast. Bulk " A " from " good " plants gave a 17 per cent. increase over Bulk " B ", representing plants picked out as " poor ". A similar comparison of two bulks of 26C was less satisfactory, there being no significant difference in yield, but in this case the " A " bulk suffered from being composed only of such seed as was left over after taking almost all seed of most of the best selections for progeny row tests and multiplication plots.

The overall comparison of " Allen " with 26C in this test showed a 24 per cent. difference in favour of 26C in lint yield.

Other Experiments and Observations.

Permanent Rotation Experiment.

This was continued in co-operation with the Botanist. It commenced in 1948–49 on a 3-year rotation of cotton, guineacorn and groundnuts with duplicate plots of each crop each season and the yields recorded so far are shown in Table 3.

Table 3.
Yields in Lb. per Acre.

	Cotton. (S.C.).	*Guineacorn (grain).*	*Groundnuts (shelled nuts).*
1948–49	444	1665	586
1949–50	297	1424	1200
1950–51	472	1355	1209

It is not possible as yet to gauge how much of the variation in yield has been due to season, and how much to plot to plot variation in soil, but the increase of 59 per cent. over 1949–50 recorded for the 1950–51 cotton crop was not fully reflected in other experiments at Samaru.

Shedding of Flower Buds and Bolls.

A number of observations on shedding were made. In one experiment, containing 32 small plots, the furrows between ridges were swept clean and the numbers of " sheds " falling over a given period were then recorded. These showed quite large fluctuations from plot

to plot. Yields of seed cotton were later recorded, and these also showed wide variations although vegetative growth was not unreasonably irregular. The seed cotton yields were positively correlated with the counts of shed buds and bolls, indicating that the higher shedding was a consequence of a higher level of fruiting and not a precursor of poorer yield.

In this connection it is of interest that the higher yield of the permanent rotation experiment mentioned above was accompanied by a much higher level of shedding than in 1949–50. Records made by the Entomologist on sample rows for the two seasons showed more than double the total shedding over the period September 9th to November 18th in 1950 compared with 1949.

A small trial was made of a synthetic plant hormone kindly supplied by Messrs. Plant Protection Ltd. under the name "Phyomone". In the absence of knowledge about the optimum time, rate and method of application to cotton, this trial can be regarded as of only a rough preliminary nature. Four applications were made, at approximately ten-day intervals from 11th October, at a rate of 450 gallons of solution per acre containing ten parts per million of the active ingredient. Control plots were sprayed with water.

Shedding, recorded over a ten-day period after the third spraying, was slightly but significantly reduced. The yield of the first picking in early December was about 10 per cent. higher and this increase was accompanied by a perceptible drop in grade of the seed cotton. This higher yield, however, fell a little short of statistical significance and was not repeated in later pickings, so that on total yield the difference was little more than 1 per cent.

As applied in this experiment it seems that the hormone can have only a very slight effect on the retention of healthy bolls but can assist a few partially diseased or insect-damaged bolls to hang on.

More frequent and intensive applications might have had a greater effect but it might well be that any success in improving the retention of early bolls would be offset by correspondingly heavier shedding later.

Effects of Acid-Treatment of Cotton Seed.

A replicated test was carried out by members of the Samaru Agricultural School, comparing acid-treated with "raw" (saw-ginned) seed. With 18 replications, using plots of 1/31 acre, the comparison was of high accuracy. The final yields indicated no advantage whatever from the acid-treating under the conditions of the experiment. Soil moisture at planting time and rainfall subsequently were both ample, the stand of the untreated plots averaged 90·9 per cent. and the final yield 686 lb. of seed cotton per acre. Records taken during the season, however, revealed that germination was a full 24 hours more rapid on the plots sown with treated seed, and the final stand was significantly higher at 92·8 per cent. and more uniform from plot to plot.

The gain in early growth from the quicker start was plainly visible for some weeks and was reflected in the first picking, which gave a statistically significant difference in favour of treated seed of 21 per cent. There was also a clearly perceptible difference in the first appearance and early spread of symptoms of bacterial blight, though these never appeared serious enough to have much effect on yield.

It seems therefore that, while no advantage in final yield can be expected under good conditions here using normal seed rates and with careful planting, acid treatment could well prove helpful in less favourable conditions. The Agricultural Officer in charge of agronomic experiments at Samaru reports an average stand of 86·9 per cent. over six experiments sown with raw seed and an average of 94·5 per cent. in three experiments in which acid-treated seed was used. The routine use of treated seed as an aid to good stand in experiments seems clearly desirable while its value in breeding and multiplication plots where low seed rates have to be employed is indisputable.

The Induction of Angular Leaf Spot by Spraying.

An attempt to produce a heavy and uniform infection of *Xanthomonas malvacearum* on foliage by spraying with inoculum, prepared from infected leaves of the previous season, was a failure. Owing to low temperatures and overcast weather the attempt was not made until October by which time the plants for spraying, although late sown (August 2nd), were perhaps too old and the diseased leaves (stored in sacks throughout the rainy season) probably no longer infective.

The purpose was to enable a search to be made within " Allen " for plants of high resistance. The writer's proposal to do this has, however, been taken up at Namulonge where there are facilities for producing effective inoculum (see p. 17).

Exposure of Cotton Plants to Leafcurl.

Strains of cotton known to differ greatly in their response to leafcurl in the Sudan, together with one Sudan type of *Hibiscus esculentus*, were planted on heavily manured soil interspersed with rows of local *H. esculentus* in a garden in which earlier plantings of this vegetable were already showing leafcurl.

Whitefly quickly became numerous on the cotton, and the Sudan *H. esculentus* soon showed typical leafcurl symptoms. Throughout the whole season, however, no trace of leafcurl could be found on any of the cotton plants, whether these were susceptible or resistant types. The experiment was therefore of no assistance in confirming the identity of Sudan and Nigerian leafcurl.

This disorder is in fact extremely uncommon on cotton in Northern Nigeria, and has not yet been observed at Samaru, although a few

relatively mild cases were found at Daudawa this season. On *H. esculentus* symptoms are typical, severe and widespread in occurrence.

Fertiliser Trials.

Various manurial experiments in which cotton is one of the crops grown are being carried out by the specialist staff of the Department of Agriculture. The following section, kindly supplied by Mr. Greenwood, the Senior Chemist, Samaru, is included by courtesy of the Director of Agriculture.

D.N.P.K. Trials.

At all major experiment stations in Northern Nigeria long term trials are in progress to determine the main effects and interactions of organic manures and fertilizers applied annually to the local crop rotation. There are 81 treatments comprising combinations of the following :—

d0, d1, d2	= Pen manure (F.Y.M.)	at 0, 1 and 2 tons per acre.
n0, n1, n2	= Ammonium sulphate	at 0, 50 and 100 lb. per acre.
p0, p1, p2	= Single superphosphate	at 0, 50 and 100 lb. per acre.
k0, k1, k2	= Muriate of potash	at 0, 25 and 50 lb. per acre.

During 1950–51, cotton was the test crop at two of these stations : at Daudawa, where two years of cotton follow one year of sorghum to which 3 tons per acre of pen manure are normally applied, and at Samaru, where cotton is the opening crop of the 3-course rotation cotton-sorghum-groundnuts.

At Daudawa the only significant increases in yield were given by pen manure and sulphate of ammonia. These were effective at both rates of application. The higher rate gave significantly greater yields than the lower only in the case of pen manure. Yields of seed cotton in lb. per acre were as follows :—

d0 = 275 ; d1 = 355 ; d2 = 406.
n0 = 303 ; n1 = 358 ; n2 = 374.
1% significant difference = 47

A significant response to sulphate of ammonia, but not to pen manure, had been recorded on these same plots in the season 1949–50.

At Samaru a new site had to be used for the 1950 experiment and this had already just received an overall dressing of 3 tons of pen manure. Yields were high (ranging from 607 to 801 lb. of seed cotton per acre) and there was no significant response to treatments.

Time of Application of Superphosphate.

In the Fertilizer Distribution Scheme, by which 40,000 peasant farmers per annum receive a trial issue of 56 lb. superphosphate, it had in the first place been recommended that fertilizer should be placed with the seed. Peasant preference is to place the fertilizer with the seedling : this practice leads to no loss of effect with groundnuts, though there are good indications that the earlier application is desirable with sorghum.

At Samaru in 1950 60 lb. superphosphate per acre were applied to cotton (*a*) with the seed (*b*) after germination (*c*) at first thinning. The intervals *a-b* and *b-c* were each ten days ; superphosphate was used in the form of both powder and pellets and applied either in lines or holes 3 in. from the seed. In 1949 the land had been under a cover-crop of mucuna which had received 2 tons per acre of farmyard manure. Non-manured plots gave the exceptionally high yield of 645 lb. seed cotton per acre and the main effect of superphosphate was only +49 lb. There was no significant difference due to either time or method of application.

Superphosphate Distribution.

The distribution of superphosphate to assist the multiplication of 26C cotton by peasants in the Daudawa area was continued and 233 tons were issued. In his Quarterly Report for December, 1950, the Senior Agricultural Officer, Daudawa says :—

> " The guineacorn crop on the settlements is appreciably higher than last year. Where guineacorn has followed cotton treated with superphosphate in 1949 settlers are enthusiastic about the very convincing residual effect ".

PROGRAMME FOR 1951-52.

Work is being concentrated on the more promising small bulks of 26C material likely to give some immediate advance in yield and an improvement in lint quality and uniformity without change of general character. A replicated trial containing 33 of these has been planted together with a series of parallel plots for seed multiplication and single plant reselection work. Some mixtures each containing seed of several separate derivatives of 26C are also under trial. Much of the other pedigree line material and many new single plant selections have had to be left in store for one season pending the completion of analysis of the laboratory data which was not possible before leave intervened.

Seed stock trials are being carried out at Samaru and Daudawa, but only of 26C and its derivatives, the comparison of these with " Allen " being discontinued.

The District Variety Trials have been dropped for one season. It is intended to recommence and extend them next year.

Various minor investigations are being continued and, by arrangement with the Senior Chemist, a test of the effect of applications of sodium on shedding has been laid down.

ENTOMOLOGY

BY

A. F. H. BAILLIE & Q. A. GEERING.

Introduction.

Records of incidence of pests and of causes of crop loss have been obtained from standard observation plots at Samaru, Daudawa, Gusau and Kontagora. Pupal periods of *Diparopsis* have been studied at these stations. In addition, crop samples have been received from Bauchi (Gombe) and Yola through the assistance of the Agricultural Department. The out-station at Ibadan was closed. Further insecticides trials were held at Daudawa, and date-of-sowing trials were held at Daudawa and Samaru.

Insect Pests.

(*a*) *Red Bollworm, Diparopsis perditor* (*Clements*).

In a recent paper,* Clements, working on material consisting of adult moths including specimens from Nigeria, has shown that the West and North African species of *Diparopsis* is distinct from the Southern species, i.e., *D. castanea*, and the Nigerian species is now known as *D. perditor*. Observations made to date on its biology have not revealed any notable difference from *D. castanea*.

Development of attack.—At Samaru peaks of egg-laying occurred in October, November and December with the two main peaks in October and November, as in 1949. Total eggs laid, 1·2 per plant, were however slightly less than half of those laid in 1949. The highest peak in October was 3,790 eggs per acre per week, compared with 9,000 per acre at the same time in 1949.

In contrast, at Daudawa, the red bollworm attack was the highest so far recorded during the present survey. Egg laying commenced in late August and on Stage 1 of the multiplication scheme showed peaks of 11,900 per acre per week in early September and a main peak of 20,000 per acre in early November. Here total eggs for the season averaged 12·97 per plant compared with 1·6 in 1949. On the earliest (mid-June) sowing in the date of sowing trial, a total of 40,000 eggs was laid per acre between 13th and 20th October. In spite of this very heavy egg-laying, the proportion of shedding due to bollworm was less than in 1949.

Emergence.—The early emergence of moths from long-term pupae in 1950 commenced at Samaru during the last week of June (three weeks later than 1949) and lasted for only two weeks. The remainder of the moths emerged between mid-October and early November. The numbers of moths produced in the cages were small but probably compare with field conditions, for there was a peak of egg-laying on standover cotton in early July.

---

* Clements, A. N. 1951. "A Revision of *Diparopsis*, Hmps. (Agrotidae, Lepidoptera)". Bull. ent. Res. 42. 3. pp. 491-497.

At Daudawa early emergence from long-term pupae commenced in mid-May, reached a peak at the end of the month, and continued at a low level until mid-July. Unfortunately no further emergence was obtained owing to a high mortality of pupae in the cages. It seems likely, however, that the prolonged early emergence here in the presence of ratoons was responsible for an early attack on the main crop.

Emergence figures and egg-counts on ratoon cotton have shown a similar pattern at Gusau and Kontagora, but all the data obtained were inadequate for making detailed comparisons.

The moth flight studies have in general, therefore, confirmed the results of the previous year, and the bimodal emergence from long-term pupae seems to be a regular feature.

It was suggested in the last report that the development of long-term pupae may be arrested by the cool conditions and water-logging of the soil in July-September and that this was the primary cause of the bimodal emergence. To test the validity of this, 178 long-term pupae formed in 1950 were moved from the soil in the pupation cages on 25th May, 1951, when less than 6 in. of rain had fallen and before temperatures had dropped appreciably and emergence might be expected in the field. Half were kept under controlled conditions and half were subjected to variations in air temperature and humidity. The controlled incubator was set at 86°F. and 73 per cent. relative humidity and the uncontrolled varied between 74°F. and 86°F. with a mean of 79·5°F., and 65 per cent.-84 per cent. relative humidity with a mean at 76 per cent. Emergence from these pupae is not quite complete (Dec., 1951) but the results up to the end of November, 1951, are summarised in Table 1.

TABLE 1.
RED BOLLWORM. SAMARU 1951.
Fate of long-term pupae kept in the laboratory. Figures expressed as percentages.

	Emergence of Moths and Parasites.								*Unaccounted for.*	*Died.*	*To emerge.*
	June.	*July.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Parasites.*	*Total.*			
Incubated	18·0	45·0	11·2	3·4	2·2	1·1	9·0	89·9	6·7	1·1	2·2
Uncontrolled	2·2	12·4	47·2	14·6	2·2	—	7·9	86·5	10·1	1·1	2·2

There was not enough material available for control samples of pupae to be kept under outside conditions. The results clearly demonstrate, however, that under equable temperature conditions, and in the absence of waterlogging, emergence is not bimodal. It is also apparent that long-term development is retarded by lower average temperatures. The results thus confirm those obtained in Nyasaland.

The experiment will be repeated, and emergence under natural conditions will be compared. Natural conditions include waterlogging, which is probably the main factor inhibiting emergence of long-term

pupae during July-September, for the recorded soil temperatures do not go down to the level at which the observed prolongation of development could be expected.

Having obtained a picture of the moth flight of *Diparopsis* it was decided to lay down a date of sowing trial, to see whether it would be possible by sowing early to escape the greater part of the October emergence. The early June emergence could only affect the main crop if ratoons were present to breed up a generation of moths during August. The four sowing dates selected covered the only practicable period of sowing, i.e., from mid-June onwards. The results of this trial are included in a later section of this report (p. 124).

(*b*) *Pink Bollworm, Platyedra gossypiella.*

This pest was very scarce again in 1950. Peak populations per acre at Samaru, Daudawa, Kontagora and Gusau were respectively 976, 1,375, 816 and 1,368, compared with 4,636 at Samaru and 6,409 at Kontagora last year. Infestations in ginneries were also low: of 205 samples of ginned seed examined 64 were infested, and in only 38 of these were living larvae found, averaging 10 living larvae per 10 lb. of seed.

TABLE 2.

P. gossypiella. EMERGENCES AND DATES OF COLLECTION 1950–51

Month of collection.	*Larvae Collected.*	*Month of Emergence of moths.*											
		Nov.	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May.*	*June.*	*July.*	*Aug.*	*Sept.*	*Oct.*
October ...	5	4	—	—	—	—	—	—	—	—	—	—	—
November	32	14	9	—	—	—	—	—	—	—	—	—	—
December	13	—	1	1	—	—	2	2	1	—	2	—	—
January ...	1	—	—	—	—	—	—	—	—	1	—	—	—
February	17	—	—	—	—	—	1	—	—	—	2	—	1
March ...	27	—	—	—	—	1	5	—	1	1	1	—	—
April ...	8	—	—	—	—	—	—	—	3	—	1	—	—
May ...	4	—	—	—	—	—	—	—	—	—	—	—	1
June ...	2	—	—	—	—	—	—	—	1	—	—	—	—
Total ...	109	18	10	1	—	1	8	2	6	2	6	—	2

The study of the length of diapause is not yet complete. In 1950 larvae were scarce and a high mortality occurred again in those larvae placed under observation. The results obtained are shown in Table 2. It was again found that a considerable proportion of diapause larvae pupate and the moths emerge long before cotton is susceptible to attack. Thus the close season, and the effectiveness of saw gins in removing larvae from seed and so giving a degree of control, should effectively prevent pink bollworm from becoming more than a minor pest. A close season cannot be so effective against *Platyedra* as against *Diparopsis* because of the possibility of its breeding on wild alternate host plants (*Hibiscus* spp.). We have recorded populations of pink bollworm of up to 800 per acre in August on *Hibiscus esculentus*, which fruits some two months before cotton.

(*c*) *Other Bollworms.*

Egyptian bollworm (*Earias insulana*) and spiny bollworm (*Earias biplaga*) were commonest as before at Kontagora, where the prolonged cotton season favours their build-up. Populations here reached 2,700

in January, 1951, but elsewhere they were small. False codling moth (*Argyroploce leucotreta*) was rare, and American bollworm (*Heliothis armigera*) only slightly more in evidence than last year.

(*d*) *Stainers* (*Dysdercus superstitiosus*).

Populations were very low everywhere except at Kontagora, where they were recorded in the crop continuously from early November to the end of January. Investigations into the breeding cycle should be complete next year. So far, observations and counts have been made during the dry season, and the known tree hosts have held and bred considerable populations. These were kapok (*Ceiba pentandra*) ; baobab (*Adansonia digitata*) ; *Bombax* sp. ; and to a lesser extent *Sterculia* spp. The highest counts were recorded on kapok in March when stainers were seen to feed on fallen seeds around the base of the tree. Numbers diminished throughout May, when dispersal took place and all stages, but particularly later ones, were found scattered throughout the bush far from known host plants. They first appeared on ratoon cotton in late May, but continued to exist in very small numbers on and around their tree hosts until August. A stainer host preference trial being held at Samaru should yield additional information on the cycle on herbaceous hosts. Adults were first recorded on millet (*Pennisetum typhoideum*) in late July, but did not breed ; since then they have been seen mainly on *Hibiscus cannabinus*, and especially *Hibiscus esculentus*.

Other possible dry season hosts are : the small bush, *Zizyphus spina-Christi* on which all stages were recorded on the leaves and stems for several weeks in April and May, at Daudawa and Zaria, but no feeding was seen ; and *Waltheria americana*, (Sterculiaceae) a very obnoxious weed in Adamawa province, on which all stages were feeding in profusion in the early part of the rains.

(*e*) *Lygus vosseleri and Campylomma sp.*

It is not known whether *Lygus* or *Campylomma* plays the principal part in causing leaf-tattering in N. Nigeria ; the former is relatively uncommon whilst the latter is abundant on cotton in October-November, as shown by the population counts at Samaru and Daudawa in Table 3. The populations were estimated by sweeping standard lengths of ridge three times.

Table 3.

Comparative counts of Campylomma and Lygus, 1950. Numbers of Adults caught per acre.

Locality.	*Date.*	*Campylomma.*	*Lygus.*
Botanist Trial A21, Samaru	18 October	14,000	280
Botanist Trial A22, Samaru	17 October	12,600	70
Botanist Trial A23, Samaru	21 October	15,400	190
Bush Plot 4	13 October	16,400	40
Experimental Area, Daudawa	27 October	1,300	0
Stage 1	26 October	3,800	50

By far the greater part of the catch was *Campylomma*. Previous tests indicated that about four-fifths of the *Campylomma* population was caught in the first three sweeps.

It was found that during the period of peak populations *Lygus* averaged only 1 per cent. of the catch of *Campylomma*. Both species diminished during November, and on the last record, on 27th December, *Campylomma* was down to 138 per acre, while *Lygus* had disappeared during the previous week. Confining *Campylomma* on growing cotton plants was inconclusive as all died within two days. It is known that very small populations of *Lygus* can cause severe damage to cotton, and it cannot yet be assumed that *Campylomma* is responsible for the bulk of the damage. In the coming season it is hoped to discover more about the role of these two and a third mirid (*Psallus* sp.), which occurs in smaller numbers.

On a variety trial at Samaru, counts were made of plants showing severe leaf damage, and these expressed as a percentage are included in Table 4, with the associated populations of *Campylomma*, and of a predatory mirid, *Deraeocoris* sp.

TABLE 4.

COMPARATIVE COUNTS OF CAMPYLOMMA SP., DERAEOCORIS SP. AND LEAF TATTERING, TRIAL A22 SAMARU

Variety.	*Campylomma* 1000's *per acre.*	*Deraeocoris* 1000's *per acre.*	% *of plants showing severe leaf tattering.*
26C Stage 1	17·5	1·9	20·5
26C 4721	18·9	1·1	15·7
MU8	13·2	3·0	2·1
MU8 × U4	14·5	2·6	6·7

The first two varieties (26C) compared with the second two (MU8), held greater populations of *Campylomma*, and the difference approached significance. There was significantly more leaf tattering on the 26C varieties, positively correlated with greater *Campylomma* populations. Associated with leaf tattering is the killing of very small flower buds, which turn brown and then shed. The young leaves have irregular brown spots which split when the leaf expands, giving the characteristic tattered appearance. Both adults and nymphs of *Campylomma* are nearly always congregated near the young growing points.

Deraeocoris sp. (Miridae) are known for their predatory tendencies, and there was a negative correlation between this species and *Campylomma*, suggesting that it exercises a natural controlling influence.

It is not known how *Campylomma* passes the dry season, but there is probably a reserve on wild hosts. So far we have only recorded adults on benniseed and the wild *Indigofera indica*.

(*f*) *Miscellaneous.*

Helopeltis schoutedeni.—Small numbers of adults and nymphs were recorded at Kontagora during November and December; only isolated plants showed severe damage.

Agonoscelis versicolor, "Andat", the Sudan sorghum pest. Adults were recorded on very late sown cotton in Northern Niger Province, where numbers per plant ranged up to 60. Adults were also recorded on bulrush millet in July, and on early American sorghum in August at Samaru in 1951.

Sylepta derogata, Leaf roller. All stages were present in cotton from August onwards. Only localised patches showed severe damage, and removal of larvae by hand-picking provided adequate control. Parasitism by *Apanteles syleptae* (Braconidae) was high. Other minor parasites were *Cremnops* sp. (Braconidae) and *Atrometus* sp. (Ichneumonidae).

Anomis flava. The larvae of this noctuid are leaf-eaters, and were common at Samaru in October and November, when an estimated peak population of 10,000 per acre occurred. Parasites recorded were *Frivaldzkia ribesci* (Tachinidae) and *Brachymeria* sp. (Chalcidae).

Odontopus sexpunctatus. This is a Pyrrhocorid bug, like *Dysdercus*, and was found in small numbers on all of the latter's hosts.

Siderodactylus sagittarius. This weevil was noted as " common " in cotton at Kontagora in November when adults were observed feeding on the leaves.

Crop Loss.

(*a*) *Shedding.*

In 1950 the general level of shedding at all stations except Kontagora was appreciably higher than in 1949. This loss was however offset by a greater boll production. The prime cause of shedding is still obscure, but it seems unlikely to be bollworm because, with the exception of Daudawa, bollworm populations were smaller in 1950.

The results from all areas are shown in Table 5, where the 1949 records are included for comparison.

Table 5.

Shedding 1949 and 1950, Percentage of shed buds, and of shed and aborted bolls, damaged by Bollworms.

Station.	Shed Buds.		Shed and Aborted Bolls.	
	1949.	1950.	1949.	1950.
Daudawa Std.	51·20	41·5	21·25	29·4
Samaru Std.	34·92	27·3	23·49	17·6
Samaru Bot.	43·15	30·1	26·18	21·6
Kontagora	58·00	61·7	47·38	62·1
Gusau	—	45·5	—	36·4
Yola : Local	40·05	47·1	35·63	54·8
Yola : Ishan	—	42·7	—	45·1
Yola : American	59·20	55·5	31·36	35·7
Yola : All varieties	—	50·4	—	37·5
Gombe	41·65	48·2	28·37	24·9

As in previous years, boll-shedding was generally heavier than bud-shedding, and reached a peak during November. The heaviest shedding occurred at Samaru on the rotation experiment, where peak figures of 5,000 and 33,000 per acre, for buds and bolls respectively, were recorded in one week in November. Shedding due to bollworms was again greatest at Kontagora, but at Daudawa even with a very heavy bollworm attack the proportion of buds shed due to bollworms was less than in 1949, and the proportion of bolls shed due to bollworm showed only a slight increase.

(*b*) *Damage to mature bolls.*

This is listed in Table 6. The proportion of clean locks was generally maintained at a high level except for Kontagora. Stage O

Daudawa showed a rather low proportion of clean cotton in spite of being dusted twice. Kontagora has again shown a very low proportion of clean cotton, and high bollworm damage.

TABLE 6.

CROP LOSS. PERCENTAGE LOCK DAMAGE IN NON-SHEDDING BOLLS.

	Daud. St. 1.	*Daud. St. 0.*	*Daud. Settlers.*	*Sam. Std.*	*Sam. Bot.*	*Sam. Peasants.*	*Kont.*	*Gus.*	*Gombe.*
Clean	70·7	66·3	79·1	80·1	69·1	76·0	44·1	72·9	73·3
Bollworm Partial loss	4·2	5·5	4·1	4·0	4·1	3·5	26·2	5·1	2·0
Bollworm Complete loss ...	3·2	4·9	3·0	6·4	6·8	2·8	8·6	8·3	4·0
Non-Bollworm Partial loss ...	12·3	10·5	6·7	7·1	15·5	13·4	13·1	7·5	13·8
Non-Bollworm Complete loss ...	9·5	12·8	7·1	2·4	4·4	4·3	8·0	6·0	6·9

A comparison between the three seasons 1948–1950 is shown in Table 7. The values are based on the standard plots laid down at each station. The most striking feature is the consistency of the level of bollworm damage at Daudawa, particularly in view of the eight-fold increase in egg-laying by *Diparopsis* in 1950 : in this season the reduction in clean locks is attributable to a large increase in non-bollworm damage. At Gombe a large drop in both bollworm and non-bollworm loss more than doubled the proportion of clean locks.

It is clear that non-bollworm loss can be an important factor in reducing yields. As previously explained (Rep. Exp. Stas. 1948–49, p.133) the non-bollworm partial loss is chiefly attributed to stainers but primary bacterial infections may be important in the category of complete loss.

TABLE 7.

SEASONAL COMPARISON OF PERCENTAGE CLEAN AND BOLLWORM-DAMAGED LOCKS IN MATURE BOLLS ; EXPRESSED TO NEAREST WHOLE NUMBER.

	1948.		1949		1950.		1950 *cf.* 1949.
	Clean	*Bollworm.*	*Clean*	*Bollworm.*	*Clean*	*Bollworm.*	*Non-Bollworm damage.*
Daudawa ...	75	6	86	8	71	7	Large increase
Samaru	75	11	59	27	80	10	About same
Kontagora ...	46	9	41	30	44	35	Slight drop
Gombe	No records		34	25	73	6	Half

INSECTICIDE TRIALS.

Two experiments were held in 1950, both again at Daudawa. The first was in the experimental area adjacent to the date of sowing trial, and the second on the Eastern extremity of Stage 1, in the same area as the Standard plot. The same treatments and layout were used for both. These were :—

1. DDT plus BHC emulsion at high volume and low concentration. 5·1 lb. DDT and 0·37 lb. γBHC per acre, at 0·6% and 0·04% respectively.
2. DDT plus BHC emulsion at low volume and high concentration. 4·1 lb. DDT and 0·29 lb. γBHC per acre, at 1·6% and 0·12% respectively.
3. DDT plus BHC wettable powder at high volume and low concentration. 3·1 lb. DDT and 0·27 lb. γBHC per acre at 0·4% and 0·03% respectively.
4. DDT plus BHC wettable powder at low volume and high concentration. 3·1 lb. DDT and 0·27 lb. γBHC per acre at 1·2% and 0·1% respectively.
5. Untreated.
6. A proprietary dust containing 5% DDT, 3% γBHC and 40% sulphur.

All percentages expressed weight for weight

The experiments were laid out as randomised blocks with eight replications, and each plot was 1/33·6 acre. Both experiments were sown on 3rd and 4th July.

The high volume sprays were applied at 2½ gallons per plot (84 gallons per acre) and the low volume ¾ gallon per plot (25 gallons per acre). The dust was applied at 44 lb. per acre, (cf. 24–35 lb. per acre in 1949 experiments.)

These trials were designed principally to control red bollworm, and it was considered essential to aim at killing the first instar larvae. Accordingly, the first application was made on 24th and 25th October just after the October egg-laying peak. BHC was not used on the first occasion, but was included in the second application, on 9th and 10th November, directed against the second egg-laying peak, by which time there were signs of an aphis infestation. A further small peak of egg-laying occurred in early December and the third application was made on 5th December when treatments 1 and 3 were omitted. The yields of grade 1 seed cotton are given in Table 8.

Table 8.

Insecticide trials, Daudawa 1950. Yields in lb. per acre of seed cotton.

Treatments.	*No. of applications.*	*Expt.* 1.	*Expt.* 2.
1. High volume emulsion	2	511	794 (4* and 5*)
2. Low volume emulsion	3	511	833 (all* except 1)
3. High volume wettable powder...	2	470	661
4. Low volume wettable powder ...	3	489	613
5. Control	–	442	591
6. Dust	3	552	692

Only in experiment 2 were there significant differences (at P= 5%), shown by asterisks. In experiment 1 the yields followed the same trend.

These results confirm those of the previous season in demonstrating the superiority of emulsion over wettable powder preparations. The dust gave a more promising result than in 1949, probably owing to the very much higher rate of application. Although the actual yield was greater than the control by 100 lb., the difference was not significant ; yet in the analysis of locks the dust, together with the low volume emulsion, showed the lowest incidence of bollworm damage—see Table 9.

Table 9.

Insecticide Trials. Daudawa 1950. Percentage bollworm lock damage in mature bolls.

Treatments.	*Bollworm.*	
	Expt. 1.	*Expt.* 2.
1	9·0	4·5
2	7·6	3·2
3	12·8	5·0
4	11·4	5·2
5	15·3	10·4
6	8·3	2·7

Significant differences were found only in Expt. 2. Treatment 5 had the highest percentage of bollworm damage (P=1%). Treatments 6 and 2 were better than all others in reducing bollworm damage (P=5%). No differences in stainer damage.

In experiment 1 a measurable control of *Diparopsis* was obtained, based on larval counts. Here the two emulsion rates, and low volume wettable powder, showed significant (P= 5 per cent.) reductions of larvae compared with the controls and dust. There were no significant reductions in experiment 2 although the high volume emulsion showed a comparatively small population and the control plots showed the greatest population. Although these observed differences in larval populations do not entirely agree with the bollworm damage recorded in Table 9, all the evidence suggests that the increases in yield resulted from the control of *Diparopsis*, which was again the dominant species of bollworm present.

The main object of these experiments has been to ascertain whether a sufficient degree of control of insect damage could be obtained to justify the routine treatment of the seed multiplication scheme. The results from the second experiment carried out on part of the multiplication scheme are encouraging. The yield from the best treatment, namely three applications of the low volume emulsion, showed a 40 per cent. increase over the control plots, and a 98 per cent. increase over the remainder of Stage 1 (419 lb. per acre). There is thus a suggestion that the increase over control in the experiment is less than it should be, owing to a general protective effect.

The results obtained this season are a great improvement over those of 1949. This can be ascribed to :

(*a*) The fact that the main attack started so late that the whole of the spraying was done at the end of the rains.

(*b*) The smaller number of applications of stronger solutions, and heavier rates of dust.

(*c*) The high incidence of red bollworm egg-laying.

In view of these results it is fully worth while to continue experiments for selecting the best treatments, with a view to treating stages O and 1 of the multiplication scheme. There were no obvious differences between high and low volumes, but the latter is a more convenient method of application, and this and dusts offer the most economical methods of application.

Date of Sowing Trials.

The object of the sowing date trials held at Samaru and Daudawa was to follow the pattern of crop production and loss in relation to red bollworm activity. The dates selected for trial covered the period practicable for peasants to sow cotton after all food crops have been sown.

The dates selected were :

A. June 17th. Two weeks earlier than the earliest recommended date.

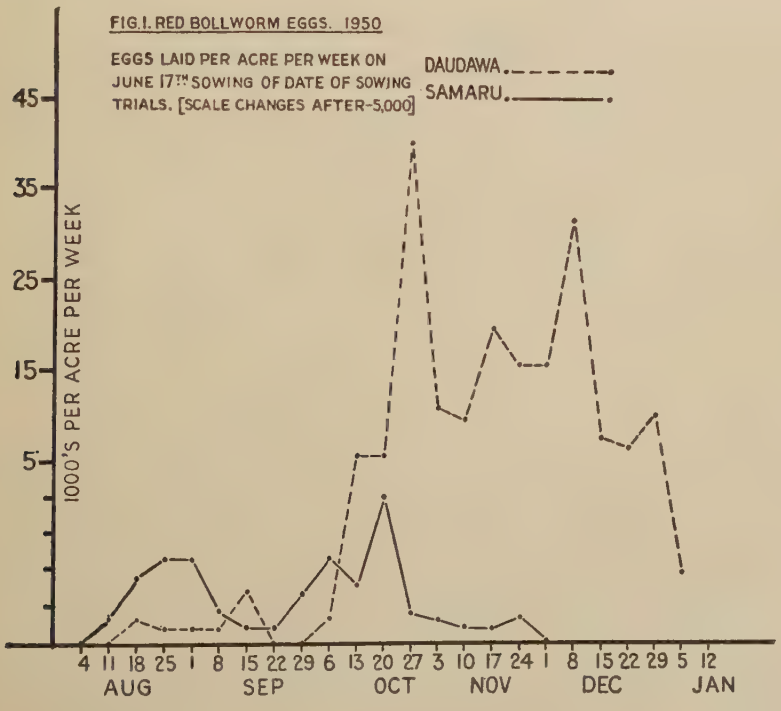
B. July 3rd. Earliest date of the period recommended by the Department of Agriculture.

C. July 18th. Latest date recommended by the Department of Agriculture.

D. July 29th. Considered " late ".

There were six replications of each sowing date in a randomised block lay-out which was identical at Samaru and at Daudawa.

On both trials counts were made through the season of red bollworm eggs. Shedding and its causes were also followed, and at Samaru the fate of individual flowers was followed by daily tagging. The heavier attack at a time more likely to be characteristic of the future occurred at Daudawa where less detailed recording was possible, and the results from which consequently cannot be analysed in very great detail. At Samaru the main bollworm attack came early and finished by mid-December, while at Daudawa the attack started later and continued at a high level until the end of December. The breeding of a second generation on the earlier sowings also probably adversely affected the later sowings. These differences in time and degree of bollworm attack between the two localities are well illustrated by the egg-counts shown in Fig. 1.



The attack which developed at Samaru represents the type of early infestation which may develop in the presence of ratoons. The situation at Daudawa represents the attack produced by a predominantly late emergence from long-term pupae, and is a situation which will always have to be faced (in varying degrees of intensity) even if ratoons are completely eliminated. This very great difference in attack must be borne in mind when considering the results summarised below. These are very condensed and a more detailed analysis will be prepared later.

TABLE 10.
DATE OF SOWING TRIALS.
Yields Grade 1 Seed Cotton in lb. per acre.

Treatments.	*Samaru.*	*Daudawa.*
A. 17 June	537 (C* and D**	439 (C* and D*)
B. 3 July	505 (D**)	462 (C* and D*)
C. 18 July	481 D(*)	336
D. 29 July	371	279

*P=5%. **P=1%.

The yields obtained are shown in Table 10. These demonstrate the superiority in both localities of the June and early July sowings over the two later July sowings.

An examination of mature bolls for direct losses is summarised in Table 11. The most notable feature was that at Samaru the earliest sowings (while outyielding the later ones), had a smaller proportion of clean cotton and more bollworm damage than the later sowings. In contrast, at Daudawa all sowings showed approximately the same proportion of clean cotton, and no falling-off of bollworm damage in the later sowings.

TABLE 11.
DATE OF SOWING TRIALS.
Analysis of lock damage as percentage of total locks.

Treatments.	*Clean.*		*Bollworm.*		*Stained.*		*Rotten.*	
	S.	*D.*	*S.*	*D.*	*S.*	*D.*	*S.*	*D.*
A	67·3*	65·4	13·6**	15·0	13·5*	11·5	4·8*	8·1
B	79·4	67·2	4·1*	14·0	9·9	10·1	2·4	8·7
C	90·6	75·3	2·7	14 2	5·5	5·3	1·3	5·2
D	90·0	71·3	2·5	14·6	7·0	7·7	0·4	6·4

S=Samaru. D=Daudawa.

The flower tagging enabled the fate of individual bolls to be followed and the fates of all those produced throughout the season are summarised in Table 12. When this is examined in conjunction with the lock damage in Table 11 it is apparent that the greater boll production in the earlier sowings offset their higher shedding and direct damage. At no time however did the bollworm-damaged shed buds or bolls exceed those showing no damage. In the absence of flower-tagging at Daudawa the only figures available are of total shedding. These showed a level of shedding approximately double that recorded at Samaru, and during late October and early November bollworms were mainly responsible.

Table 12.
Date of Sowing Trial, Samaru 1950–51.
Numbers and fate of bolls formed per plant.

Sowing.	Bolls formed per plant.	Bolls shed and aborted.		Bolls matured.	
		B.W.	Non B.W.	B.W.	Non B.W.
A	17·63	0·96	9·42	1·58	5·67
B	14·72	0·38	8·45	0·67	5·22
C	12·57	0·28	6·91	0·45	4·93
D	11·14	0·22	7·22	0·28	3·42

In both localities the first two sowings suffered an early attack from moths which must have been bred on ratoons. At Samaru this constituted a considerable proportion of the general infestation resulting in the greater damage recorded on these earliest sowings. At Daudawa, however, the effect of this early attack was quite swamped by the later infestation (originating from the remaining bulk of long-term pupae).

The information from Samaru obtained from flower-tagging and shed collection, presented in Figs. 2 and 3, emphasises three main points.

(*a*) Red bollworm was a negligible factor there this season in reducing yields.

(*b*) The greater part of all flowers produced after the end of October was shed, and the sowings which produced most flowers before this date produced the heaviest crop. This later shedding can almost certainly be attributed to the severe drying conditions which, setting in at that time, act as a guillotine to further crop production.

(*c*) The very heavy shedding which occurred throughout September on the earliest sowing is not associated with adverse climatic conditions, and the exact causes were not apparent.

The conclusion to draw from these trials is that, even in the absence of heavy bollworm attack, sowing in late June or early July produces higher yields by setting the bulk of the crop before the adverse conditions set in at the end of October. If on to this unalterable basic pattern early red bollworm is superimposed (as occurred at Samaru), the early sowing is already growing under optimum conditions, and producing a greater crop than a later sowing, more than sufficient to compensate for that lost to bollworm. It seems certain that, with a rigidly enforced close season, such an early sowing would yield even better than on this occasion. If on the other hand a later bollworm attack develops on the scale that occurred at Daudawa, no alteration of sowing date will avoid it ; but early sowing will produce a crop in the best possible condition to cope with such an attack.

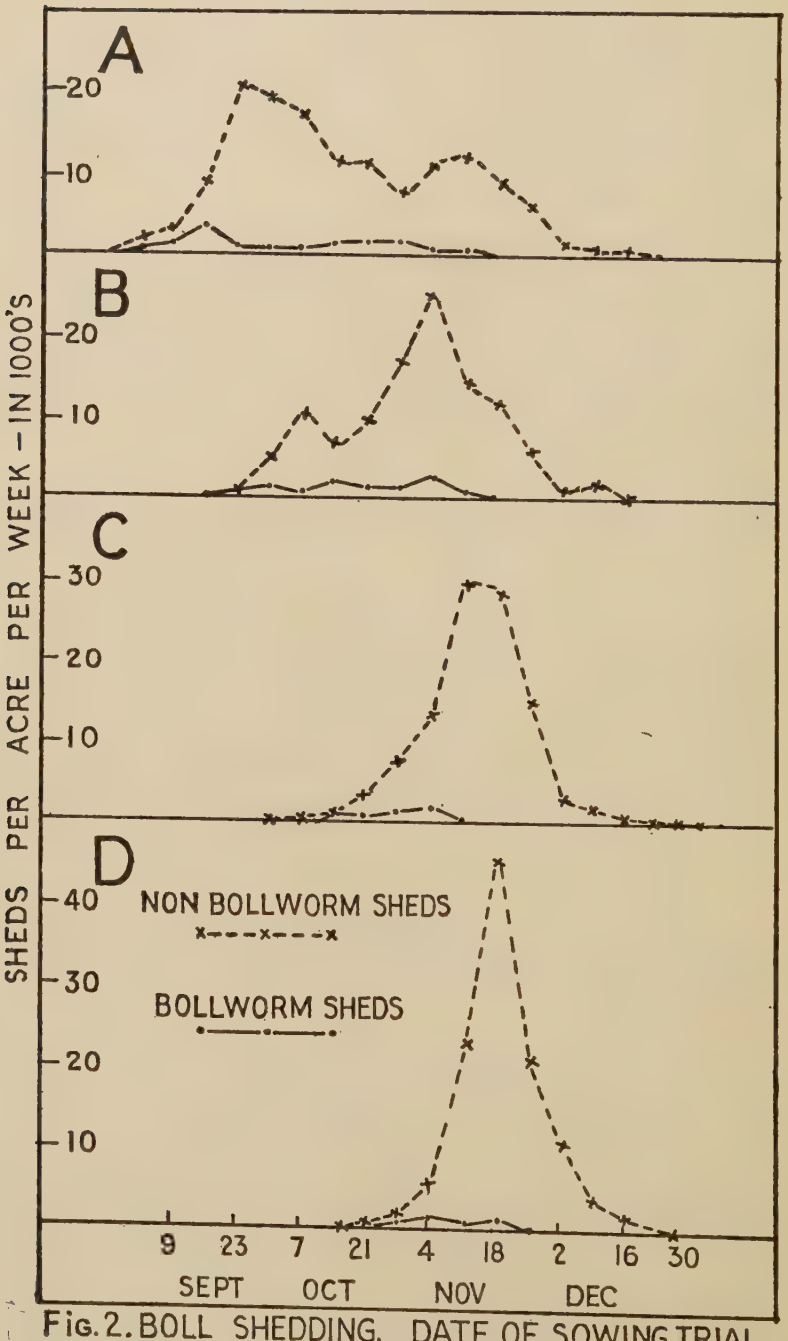


Fig. 2. BOLL SHEDDING. DATE OF SOWING TRIAL. SAMARU. 1950.

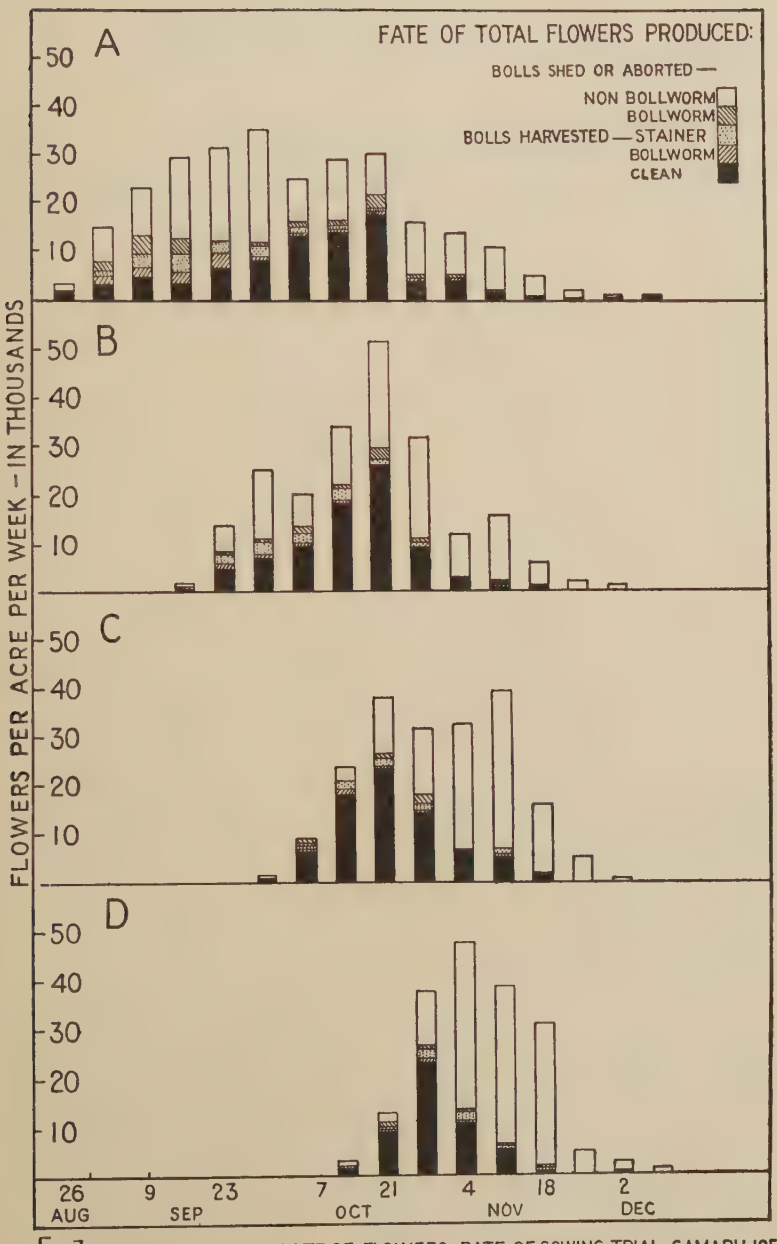


FIG. 3. PRODUCTION AND FATE OF FLOWERS. DATE OF SOWING TRIAL. SAMARU 1950

PROGRAMME FOR 1951-52.

Routine records will be continued as before. The survey will be extended to Yola and Numan in Adamawa Province, and to Mokwa in Niger Province.

Special attention will be paid to *D. superstitiosus* in determining its cycle of breeding and feeding on wild and cultivated host plants throughout the year. This will include growing a wide variety of crops and plants at Samaru to determine which are true hosts and which are only subsistence plants. Further insecticides trials will be held.

Received January, 1952

WEST INDIES.

COTTON EXPERIMENT STATIONS, SEASON 1950-51.

BY

J. V. LOCHRIE AND J. R. SPENCE (ANTIGUA)

A. S. HARPER (MONTSERRAT)*

H. A. FRANCIS (ST. VINCENT)*

CROP CALENDAR.

	Antigua 1950—51	*Montserrat* 1950	*St. Vincent* 1950—51
Close Season	1st June—31st Aug.	1st Nov.—31st Feb.	15th May—14th Aug.
Planting Period :—			
Main Crop	Sept.—Oct.	March—May	Mid-Aug.—Sept.
Expt. Stations ...	Early September	Early March	Late Aug.—early Sept.
Reaping Period :—			
Main Crop	Mid-Jan.—May	July—September	Late Jan.—April
Expt. Stations ...	Mid-Jan.—April	July—August	Late Jan.—Mid-March
Rainfall :—			
Twelve months ...	49·73 ins.	—	—
Crop period	Nine months 36·60 ins.	Eight months 39·68 ins.	Eight months 59·81 ins.

COMMERCIAL CROP.

Superfine Sea Island, almost entirely the V135 variety in St. Vincent, maintained its area at over 3,000 acres, of which some 60 per cent. was grown by peasants. The yield of 114 lb. clean lint per acre was about the average of past seasons.

Localised infestations of cotton stainers, leafworm and pink bollworm occurred, but in general the pest incidence was lower than in the previous season. Small patches affected by wilt were observed in a number of places, mainly on coastal soils, and the causal organism was identified as *Fusarium vasinfectum*. Similar affected patches have been recorded earlier, but the disease was not serious and it may be that its present occurrence is due to a combination of environmental conditions favouring its development. A survey of the incidence of the disease will be made in the coming season.

The cotton position is dominated by the MSI variety which now makes up 80 per cent. of the Sea Island production, owing mainly to increased acreage and high yields in Antigua. The variety is grown in two different planting seasons, Antigua and Nevis in September—October, and Montserrat and St. Kitts in March—April. The acreage, 10,600 this season, was a little higher than last year.

The Antigua crop, following some planting delays due to hurricanes, had a favourable season free from pink bollworm and averaged 207 lb. clean lint per acre, while the Nevis yield rose to 136 lb. Dry conditions both in Montserrat and St. Kitts made crop establishment difficult

* Reports included by courtesy of the governments of the Leeward and Windward Islands respectively.

and this, combined with heavy pink bollworm infestation, reduced yields to 100 and 129 lb. respectively. The season again stressed the precariousness of March—April planting and the need for further knowledge of the causes of the periodic heavy bollworm attacks.

Experimental Stations.

Antigua.—On the station conditions were favourable and the crop averaged 400 lb. lint per acre. This increase of 100 lb. per acre over last year was mainly due to freedom from pests, particularly pink bollworm.

Fertilisers have never given any spectacular results and there was little response in this year's range of trials. Pen manure has given consistent yield increases on the station, and in this season's investigation of residual effects increases in yield were again in proportion to the amounts of pen manure originally applied. Similarly, there was a beneficial residual effect of phosphate but again no response to applications of potash.

Further information has accumulated on the effect of rotations and on the handling of the land during the cotton close season. Green manuring, whether for a whole year or during the close season, is beneficial and the yield of cotton is improved by early ploughing in of plant residues. From the results of these and earlier trials it is clear that a general yield increase will come from improvements in cultivation practices.

The lower quality of MSI grown in Antigua and Nevis is due to environmental causes and improvement will depend on the substitution of a higher quality cotton ; to meet this need, work on selection and trial of possible replacement strains has been considerably expanded. Material of good spinning value is available but, though yields this season were promising, more information is needed on the yielding capacity under average conditions of cotton cultivation.

Pink bollworm (often the cause of heavy crop loss in the various islands) was very slight in Antigua and no evidence of the efficiency of insecticides could be obtained. However other pests, particularly leafworm and *Pentatomids*, occurred and were efficiently controlled by a number of insecticides resulting in useful yield increases.

Montserrat.—At the station the programme of maintaining the MSI variety and of supplying pedigree seed for multiplication to the other MSI growing islands was continued. The station area was fortunate in getting the crop established early and, though conditions were dry during the early growing period, fair yields were reaped. Some of the district field trials, like much of the commercial crop, had difficult conditions for establishment and were useless through patchy stands, late cropping and heavy bollworm attack.

From the manurial trials which did survive there was further evidence of the value of applications of sulphate of ammonia on the light soils and also a beneficial effect of pen manure. The season also gave a striking demonstration of the value of shelter belts in a year of low rainfall and high winds.

Trials of times and methods of land preparation gave results similar to those recorded earlier in Antigua. Delayed preparation of the land reduced yields ; particularly where cotton is to follow a grass ley, the land should be ploughed well in advance of planting.

St. Vincent.—On the Camden Park station climatic conditions were somewhat unfavourable at planting, resulting in rather patchy stands. The V135 selection and seed renewal scheme was continued and further work done on the VH8 material. Strains of the latter have been isolated with yarn strength equal to that of V135, but evidence is still needed of the relative yield capacity of the two varieties. The single comparative trial this year under commercial cotton growing conditions was late planted and patchy in stand and growth. Yields were very low and, though VH8 outyielded V135, the superiority needs confirmation from a wider range of trials.

Fertiliser trials over a range of soil types again showed the general need for nitrogenous manures and it is encouraging to record that there is a steady increase in their use in commercial cotton growing.

COTTON EXPERIMENT STATION, ANTIGUA.

Meteorology.

The monthly rainfall figures are tabulated below. The mean monthly temperatures have shown very little variation from year to year since the station was opened and will no longer be included.

	June	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Total.*
1950—51	1·55	1·99	9·53	7·59	4·11	3·78	2·88	3·05	1·69	0·99	2·49	10·08	49·73
30 year mean	3·82	3·74	4·43	4·77	5·22	5·35	2·86	2·38	1·62	1·54	2·04	3·27	41·04

The close season was drier than usual ; though the rains which accompanied the hurricanes of August 21st–22nd and August 31st–Sept. 1st provided ample moisture, they delayed planting somewhat especially in experiments outside the station. Germination was good, but early growth was only fair ; this is attributed to the leaching of soil nitrate in the heavy rains just before planting. Conditions later were satisfactory until January, when high winds and falling soil moisture caused considerable shedding of young bolls. The average station yield was about 400 lb. lint per acre, an increase of 100 lb. over the previous season.

AGRICULTURE.

Previous manurial investigations on the station have shown no response to potash, and this is in agreement with soil analyses of the sites. The effects of sulphate of ammonia have been variable and responses have been traceable to conditions of deficiency, either through leaching rains around planting time, or where considerable plant residues have been incorporated in the soil shortly before planting. Small but consistent yield increases have followed the application of superphosphate but no further gains have resulted from applications above the lower limit of 200 lb. per acre broadcast.

The work this season has included the following up of residual effects of pen manure and phosphate on the station, and the carrying out of a scatter of fertiliser trials in the cotton growing areas.

Pen manure.—This trial had applications for three successive years and this is the second cotton crop on which the residual effects have been measured.

Analyses show the average equivalent per ton of the pen manure applied over the period to be 124 lb. sulphate of ammonia, 82 lb. of 20 per cent. superphosphate and 67 lb. sulphate of potash. The NPK comparison was calculated to be the equivalent of 18 tons of pen manure of this analysis.

The layout comprised five blocks with plots of 1/42nd acre, planted on 15th September at $3\frac{1}{4} \times 2$ foot spacing, with two plants per hole left at thinning.

The treatments and a summary of yields over the term of the trial are :—

TABLE 1.

Treatments. Total applications over the three year period.	*Yields in lb. seed cotton per acre.*						*Lb. per acre increase over five years.*
	1946—47 *Direct.*	1947—48 (1) *Cumulative.*	1948—49 (2) *Cumulative.*	1949—50 *Residual.*	1950—51 *Residual.*	*Total five years.*	
1. 9 tons	1,083	415	1,670	738	1,030	4,936	809
2. 18 tons	1,085	432	1,816	878	1,239	5,450	1,323
3. 27 tons	1,020	453	1,678	933	1,407	5,491	1,364
4. NPK	912	389	1,610	778	1,103	4,792	665
5. No manure ...	810	318	1,468	638	893	4,127	—
C.D. at 5%	133	75	196	109	167	—	—

(1) A very dry and short season with heavy crop loss through *Nezara*.

(2) "Chibble Leaf" disease occurred in the trial and was greatest on treatment 3, which had the heaviest application.

The results follow the same trend as last year, with increases from pen manure in proportion to the rates of application and a less return from artificials. The pattern over the whole course of the trial would have been still more definite but for the attack of "Chibble Leaf" in 1948–49 which reduced the yield of the highest pen manure series. This experience was useful in stressing the need for care in manurial application and in practice lower levels of 2–4 tons per acre applied more frequently would be safer.

$3 \times 3 \times 3$ *NPK experiment.*—The residual effects of fertilisers were investigated for a second season in this trial, which had received fairly high levels in 1947–48 and 1948–49.

As before, the only effect was that of phosphate, with a significant yield increase of 16 per cent., but with no difference between P_1 and P_2. Four successive cotton crops have been reaped and it is proposed to continue the trial for a further season to see whether the large application given to P_2 takes effect.

This trial, as others, has at no time shown any response to potash, and it seems clear that under the system of cotton growing here potash is not a limiting factor. However it will be seen later, in the Land Use section, that symptoms of what appears to be potash deficiency occurred in a rotation trial and it may be that, with cotton following a long ley with high yields of grass removed, potash manuring may be necessary.

District fertiliser trials.—NP trials of Latin square design, including both broadcast and placed superphosphate, were carried out at 5 sites covering the various soils in the cotton area. Superphosphate was applied before planting at the rate of 150 lb. per acre broadcast and 50 lb. per acre " placed ", while the sulphate of ammonia was given in two applications, of 50 lb. each, at planting and before the start of flowering. The trial on the volcanic soil at Cades Bay failed owing to heavy attack by *Nezara* on one section. The others yielded well, averaging 1,200 lb. seed cotton, but responses to manuring were not significant. The only indication was in favour of phosphate at one site.

The lack of any considerable response to fertilisers in trials in Antigua under reasonable conditions of cotton growing has been common experience, and it is clear that increase in the general yield level will come rather from improvements in the standard of other agricultural practices. Late land preparation is still all too common and weeding of the crop too often delayed.

A further attempt was made to arrange a scatter of simple manurial and cultivation trials over peasant areas, but this again failed owing to the impossibility of getting the work done with any reliability. It is obvious that experimentation covering the varied conditions of peasant farming can only be done by simulating peasant practices on land which is under direct control.

Land Use.

Rotation trial A.—The object is to investigate the effects of various cropping systems on succeeding cotton crops. The rotations are :—

1. Sugar cane—plant cane and two ratoon crops.
2. Elephant grass cut for forage over the same period.
3. Continuous cotton, as is common practice.
4. Continuous cotton broken by a year of leguminous cover crop.

The trial included an unmanured series and one receiving a heavy dressing of superphosphate at the beginning of the rotation plus sulphate of ammonia applied annually to the rotation crops. The test rotations completed their course last year and their productivity over the period and their response to manuring were given in the last report. Cotton was planted over the area this season and received no direct application of fertilisers.

A split plot design with 5 replicates was used, the manures in the whole plots and the rotation treatments in sub-plots of 1/39th acre. The crop was planted on 6th September at a spacing of $3\frac{1}{3} \times 1$ ft. with one plant per hole left at final thinning.

Table 2.

Treatment.	*Growth as % of 3.*		*Flowers % of 3.*	*Yield lb. seed cotton p.a.*	*Yield as % of 3.*
	36 *days.*	70 *days.*			
1	125·5	115·1	114·1	1,544	99·0
2	144·3	119·8	112·2	1,308	83·8
3	100·0	100·0	100·0	1,560	100·0
4	133·2	129·9	118·1	1,824	116·9
C.D. 5%	19·1	N.S.	—	166	10·7
Standard Error	± 6·55	± 7·73	—	± 57·0	± 3·66
Sig. of manuring ...	N.S.	N.S.	—	1%	1%

All treatments gave better growth and higher flowering than the continuous cotton but only in the case of green manuring was this carried through to yield. The Table of cumulative pickings shows that the effect of grass was to depress the later pickings.

Table 3.

Treatment.	*Cumulative seed cotton per acre at picking dates.*							
	29/1/51	5/2/51	16/2/51	28/2/51	13/3/51	3/4/51	13/4/51	8/5/51
1	126	302	752	1,129	1,319	1,447	1,492	1,544
2	126	380	781	1,084	1,198	1,270	1,287	1,308
3	119	322	772	1,135	1,337	1,478	1,519	1,560
4	135	352	883	1,300	1,550	1,735	1,787	1,824

" Leaf Scorch " was observed by mid January in all plots following grass and to a much less extent in cotton after sugar cane. The symptoms were a browning starting at the leaf margins and spreading inwards between the main veins leaving the veins bordered with green. It will be noted that the condition was not seen until after the onset of drying conditions in January.

The effects seen in the present experiment may be a manifestation of potash deficiency following the removal of large amounts of forage during the past 3 years, and this possibility will be investigated in the coming season.

The trial showed a significant residual effect of the fertilisers (NP) applied to the test crops. The mean increase was 16 per cent. and there was no indication of any interaction between cropping treatment and manures.

The trial will be continued for a further season with cotton as the indicator crop. The present trial was of an exploratory nature as much to determine the value of the crops themselves as their effect on cotton. In the light of knowledge gained a permanent rotation trial has been started after discussion with the Rothamsted Experimental Station. The present rotations are being included but provision is made for others such as short term close season green manures, and the layout will provide annual comparisons of the various rotation treatments.

Close Season Cropping.—A good deal of attention has been given to the handling of the land during the close season between cotton crops. The effects of a number of treatments on the following cotton crops and their relation to the wider questions of soil conservation and soil fertility have been discussed in previous reports.

Short term leguminous cover crops have shown up excellently and consideration has been given to finding a system of utilising a legume with less expense in its planting and maintenance. The method of broadcasting the seed with the field cultivation which follows the uprooting of the old cotton crop and then leaving the mixed cover of weeds and legumes through the close season was included this season. The trial consisted of one Latin square with plots of 1/53rd acre and was planted without any addition of manures on 11th September at a spacing of $3\frac{1}{3} \times 1$ foot with one plant per hole left at final thinning.

Table 4.

Treatment.	*Growth at seven weeks as % of 1.*	*Yield p.a. lb. S.C.*	*Yield as % of 1.*	*Ploughing under. Weeks before planting.*
1. Weed fallow—late	100·0	1,249	100·0	2
2. Weed fallow—early	105·9	1,393	111·5	6
3. Weed and legumes late ...	130·0	1,473	117·9	2
4. Legume late	131·5	1,428	114·3	2
5. Bare fallow	113·2	1,381	110·6	Kept clean weeded
C.D. 5%	22·6	131	10·5	—
Standard Error	± 7·33	± 42·6	± 3·41	—

The results bear out earlier findings as to the delayed growth following weed fallow and the necessity for early land preparation where weed fallowing is practised. This is not so where a leguminous cover is grown and the trial supports the suggested less costly practice of broadcasting a legume to form a mixed cover.

Land Rehabilitation.—The investigation continued on the lines described in earlier reports except for the replacement by a Guinea grass ley of the sugar cane which has been a failure on the thinner hill soils.

Fair crops continue to be reaped and it is evident that these hill soils can grow cotton, maize, and produce good yields of Guinea grass once efficient soil and water conservation measures are carried out. Responses to manuring are fair but the main point is conservation of water. In the present season the dry spell in January was accompanied

by high winds and the effect of the shelter afforded to cotton on the S.W. slope was striking. Unprotected cotton suffered considerable shedding of young bolls while this sheltered area shed little and gave excellent yields.

Cotton Breeding.

In last year's report the lower quality of MSI grown in Antigua and Nevis compared with that grown in Montserrat and St. Kitts was discussed. The difference is associated with the season at which the respective crops are planted and, as any radical change of planting season is not possible in Antigua at least, improvement can come only from the cultivation of a variety of higher quality. As a result of the poor market prospects for the low quality MSI the question of possible replacement varieties was a matter of urgency. Discussions with the Raw Cotton Commission and with spinners of Sea Island cottons suggested that there would be a place in the market for a third commercial variety with spinning value between that of MSI and V135. As a result the varieties VH8, VH10 and BD, already in the breeding programme, were bulked on a field scale so that bale samples would be available for mill tests and to provide seed for large scale multiplication should one of these be acceptable to the trade and of good agricultural possibilities.

Variety Trials.—In addition to covering conditions in the cotton areas of Antigua, trials were carried out in Montserrat and Nevis with the co-operation of the Departments of Agriculture and the results are tabulated together.

Table 5.

Place.	*MSI yields in lb. lint per acre.*	*Yields as percentages of MSI*					*Sig. Diff. at 5%*	*S.E.*
		V135	*NSI*	*BD*	*VH8*	*VH10*		
Antigua Cotton Station ...	425	99·1	90·1	111·1	109·9	114·4	18·6	*±6·56
Antigua Thibous	479	84·6	102·3	100·0	114·0	109·4	14·2	±4·87
Antigua Wetherells	481	101·5	110·0	95·4	116·4	94·4	12·1	±4·17
Antigua Rooms	401	119·7	134·1	118·0	126·7	117·5	12·5	±4·30
Antigua Belmont	267	68·5	67·0	79·4	70·8	96·3	13·5	±4·64
Antigua Cades Bay	686	84·6	85·9	91·1	90·5	98·4	N.S.	±6·19
Antigua Piccadilly	454	86·8	80·0	98·5	99·3	116·5	17·6	±6·04
Mean Yields	456	92·1	95·6	99·1	103·9	106·7	—	—
Mean Ginning %	32·6	26·3	28·7	28·0	29·1	32·3	—	—
Montserrat	204	84·8	61·8	91·2	94·6	98·0	12·3	±4·35
Montserrat Ginning % ...	31·1	24·8	25·8	27·4	26·1	30·5	—	—
Nevis—Prospect	329	93·0	80·5	81·5	97·0	94·2	9·0	*±3·12
Nevis—Cades Bay	545	79·7	85·6	79·7	91·8	96·9	12·4	±4·26
Nevis—New River	349	81·4	88·8	74·8	87·1	102·6	14·4	±4·78
Mean Yields	408	83·8	85·2	78·8	92·1	97·8	—	—
Mean Ginning %	33·3	26·3	28·7	28·6	29·9	32·0	—	—
Mean Yield all Trials ...	420	90·0	91·9	93·3	100·7	103·8	—	—
Mean Ginning %	32·7	26·5	28·6	28·1	29·1	32·3	—	—

* Statistical comparisons with VH8 and VH10 are not valid as the figures given for these varieties are the means of several substrains included in these two trials.

Over the complete series of trials this season VH10 and VH8 slightly outyielded MSI with BD only some 7 per cent. less. These promising results are, however, heavily weighted by the first four trials in the Antigua group, all of which were in the calcareous soils and got in early. The season was satisfactory and the freedom from pink bollworm allowed a long cropping period. Examination of the picking records clearly shows the advantage of the long season to V135, NSI, VH8 and BD on the calcareous soils.

The results from other centres in Antigua and those from Montserrat and Nevis follow more closely those of the previous season and it is clear that more work is needed. VH10 behaves very much like MSI but it may well be that the other varieties are more suited to conditions of good farming than the rigours of peasant practices where poor cultivation and planting delays are common. A further extensive programme of trials is proposed and provision is being made for the investigation of the varieties under various conditions of soil fertility, of land preparation and cultivation, and at different planting dates.

TABLE 6.

SPINNING TESTS. VARIETY TRIALS.

Corrected Count × Strength Products.

(a) Small Scale Spinning Tests—80's count.

Place.	*MSI*	*BD*	*VH10*	*VH8*	*NSI*	*V135*
Antigua—Cotton Station	2,442	2,748	2,525	2,936	2,920	3,004
Antigua—Thibous	2,262	2,592	2,458	2,712	—	—
Antigua—Wetherells	2,297	2,476	2,322	2,655	—	—
Antigua—Rooms	2,334	2,377	2,409	2,624	—	—
Antigua—Belmont	2,588	2,840	2,718	2,962	—	—
Antigua—Cades Bay	2,313	2,635	2,401	2,808	—	—
Antigua—Piccadilly	2,516	2,707	2,586	2,779	—	—
Antigua—1949–50	2,409	2,736	2,592	3,000	2,631	2,865
Montserrat 1950	2,579	2,704	2,660	2,824	2,951	2,872
Nevis 1949–50	2,333	2,558	2,371	2,775	2,704	2,794
Mean all trials	2,407	2,637	2,504	2,808	2,802	2,884

(b) Spinning Tests on bales from Commercial plantings.

Variety.	*Effective length 32nd inch.*	*% Short Fibre.*	*Maturity N — D*	*Fibre Wt. per cm.*		*Corrected C × S product.*		*Highest Std. Count.*
				Mean.	*Standard.*	*120's*	*150's*	
MSI ...	56	38	58—17	142	157	2,072	1,691	107
BD... ...	60	45	58—18	120	133	2,362	2,002	130
VH8 ...	64	39	58—16	115	126	2,490	2,222	147
VH10 ...	57	32	56—17	141	158	2,109	1,705	110

The spinning tests show that the varieties in the trials generally followed a similar pattern as regards yarn strength. VH10, which is close to MSI in yield and ginning percentage, gave a slight but consistent improvement over MSI in yarn strength but the difference is not enough to suggest it as a replacement, at least as it stands at present. Attention has been concentrated rather on BD and VH8, the latter being in the superfine class with BD intermediate between that and MSI. BD however has been rather disappointing in ginning percentage and on the whole has been outyielded by VH8.

Multiplication areas of VH8, VH10 and BD were grown for bulk examination by spinners and graders and to provide enough seed in the coming season to enable a complete change-over to be effected in Antigua and Nevis by 1952-53 if this should prove necessary and desirable. Sample bales were examined by the Raw Cotton Commission and mill spun by Messrs. Thomas Oliver & Sons. The results, and those of the spinning tests included in Table 6, corroborate those of the small scale tests. Following these tests the Raw Cotton Commission offered a premium on the price of MSI to Antigua growers for an amount up to 500 bales of VH8 in order to test the reactions of the trade to the variety, and arrangements have been made for the planting of about 500 acres by estates in the coming year. This further year will be valuable in providing opportunity for more field trials on the agricultural implications of a general change-over, as it must be stressed that knowledge of the performance of VH8 and other varieties on trial compared with MSI is not yet enough to decide their value for general cultivation.

The VH10 and VH8 material comprises a number of strains obtained from St. Vincent four years ago. The commercial bulks were grown from a mixture of the strains in each case but selfed bulks of the individual strains have been made and strain tests carried out on the station. The results for the past two seasons are given in Table 7.

Table 7.

Strain.	*Sub-strain.*	*Cotton Station, 1949–50*				*Cotton Station, 1950–51*			
		Yield lb. lint p.a.	*Ginning %*	*Weight 100 seeds gms.*	*C × S product 80's.*	*Yield lb. lint p.a.*	*Ginning %*	*Weight 100 seeds gms.*	*C × S product 80's.*
VH10	4415	381	31·9	13·34	2,614	469	34·3	12·70	2,491
	4416	371	31·5	13·29	2,657	473	33·0	12·96	2,541
	4419	437	31·5	13·45	2,505	515	34·0	12·65	2,542
VH8	4601	340	29·2	13·03	2,751	466	30·8	13·05	2,942
	4602	346	28·4	13·08	2,902	496	30·8	13·08	3,009
	4617	385	27·1	13·43	3,102	509	30·2	12·18	2,926
	4620	351	25·6	13·15	3,078	429	29·4	12·48	2,912
	4621	309	26·9	12·98	3,018	414	29·7	12·51	2,921
	4623	322	26·7	12·64	3,153	471	28·9	12·14	2,907
C.D. 5%	—	50	—	—	—	79	—	—	—

In the VH10 lots there are indications of yield improvement in 4419 but the three strains are alike in yarn strength and too near the present MSI to offer much promise as a replacement variety. With the exception of 4601 in the 1949–50 season the VH8 strains gave very similar yarn strengths but the trials indicate the possibility of yield improvement.

The main selection work so far has been on BD but this now seems less promising and more attention will be given to the VH cottons. Bulk samples of lint will be available for examination next season and

the opinion of the trade, together with the results of yield tests, will determine the future trend of selection.

A small plot of blackarm and leafcurl resistant Sakel (BLR 14/16) was grown from seed obtained from the Sudan. Though planted late the plants were healthy and cropped we l. A major disadvantage was that the bolls were not at all stormproof and, despite the sheltered situation of the plot, picking had to be done at intervals of three days.

There was little difference in yarn strength between this Sakel and MSI but the former was lower in ginning percentage and in seed weight and had very small bolls.

Table 8.

Sample.	*C × S product 80's.*	*Ginning %*	*Weight 100 seeds gms.*	*Lint Index.*	*Weight per boll S.C. gms.*
BLR14/16	2,369	30·48	11·89	521	2·49
MSI	2,442	33·90	12·80	656	3·48

Pests and Diseases.

With the exception of leafworm (*Alabama argillacea*) and *Nezara viridula* in scattered patches, losses by pests were not heavy this season. This is reflected in the average island yield of 200 lb. clean lint per acre, which is satisfactory in view of the fact that much of the commercial crop was late planted as a result of the disorganisation following the hurricanes at normal planting time. Had pink bollworm been present these late plantings would have suffered serious losses.

Leafworm.—This was fairly general and early, but spraying with lead arsenate was reasonably efficient and damage was slight.

Pink bollworm.—A feature of the season was the slightness of the infestation, which permitted a long cropping season. The heavy rains associated with the hurricanes would reduce infestation from resting larvae in the soil and no doubt the increased vigilance in enforcing an efficient close season contributed to the control.

Heliothis sp.—This was again recorded causing considerable losses of flower buds. Reference is made later to evidence of control by insecticides.

Insecticides.

Insecticidal control of cotton pests is at present confined to the use of arsenicals against leafworm and, where this is done efficiently and promptly, control is achieved. Other pests take toll of the crop: pink bollworm, commonly in the later part of the season, and Pentatomids (mainly *Nezara*) can be serious. Aphis is occasionally of importance, while *Heliothis* and other caterpillars may cause damage, especially to flower buds.

Insecticide trials were carried out on the station and at Cades Bay with the following treatments.

L. Lead arsenate, applied as a spray, at a rate of 1-1½ lb. per acre.

A. Agrocide Cotton Dust (3:5:40) applied at 15 lb. per acre.

T. Toxaphene (20 per cent. chlorinated camphene plus 40 per cent. Sulphur) at 15 lb. per acre.

D. DDT emulsion at rate of 2 lb. Technical DDT per acre. (The DDT was dissolved in Benzole and MB320 added as an emulsifier).

C. A 6 per cent. DDT dust applied at 20 lb. per acre.

The trials were laid out as randomised blocks, with two replicates each at the station and at Cades Bay, the plot size being 1/12th acre. The station trial was on cotton planted on 6th September, while that at Cades Bay was five weeks later. Yields were taken from whole plots, and flowering records, classification of shed material and analyses of unshed bolls were carried out on plot samples.

The investigation was concerned with the effects of the insecticides on the pest complex rather than with the economics of control measures and the treatments were started early—in mid November on the station and a month later at Cades Bay. At this stage leafworm had appeared and there was some *Heliothis* on flower buds, while *Nezara* was moving into the cotton, especially at Cades Bay. From the point of view of the investigation it was unfortunate that pink bollworm was negligible at both sites but *Nezara* and other Pentatomids occurred in quantity.

Table 9.

Treatment.	*Yield in lb. per acre Seed Cotton.*			*Shed bolls due to Pentatomids as percentage of L.*		
	Station.	*Cades Bay.*	*Mean.*	*Station.*	*Cades Bay.*	*Mean.*
L	714	1,252	983	100	100	100
A	1,138	2,081	1,609	19	26	21
T	1,107	2,055	1,581	13	13	13
D	788	1,998	1,393	17	23	20
C.D. 5%	—	—	329	—	—	—
Standard Error ...	—	—	± 102·9	—	—	—

The 6 per cent. DDT dust failed to control leafworm (lead arsenate had to be applied to prevent complete crop loss), and there was no indication of control of Pentatomids. Owing to the poor growth and development following the defoliation this treatment was abandoned. Of the other treatments all four gave efficient control of leafworm with Agrocide Cotton Dust just slightly inferior to the others.

In the absence of pink bollworm, pest control in these trials was to a great extent a matter of controlling Pentatomids. The treatments reduced shedding by these bugs to an average of about 20 per cent.

of that of lead arsenate, with some suggestion that Toxaphene was most efficient. This control is reflected in the yields ; gains of about 60 per cent. were got in the Agrocide and Toxaphene series at both centres and by the DDT emulsion at Cades Bay. The lower yield of this treatment in the station trial was due to a rapid falling off in the late pickings. The plants lost leaf early, as did those in a small subsidiary trial, also on the station, where proprietary DDT emulsion preparations had been used as well as that mentioned earlier. Aphis was not serious this season, but where the DDT emulsion was used there was some increase. It is not clear how far this was responsible for the loss of leaf, or whether some other factor contributed.

The analysis of unshed bolls at reaping showed that all three treatments carried considerably more bolls through to harvest than did the lead arsenate series, that a larger proportion were " clean " cotton, and that there were fewer bolls in the " total loss " class.

In the early attack on flower buds by caterpillars a number of insects were concerned, but *Heliothis* was mainly responsible for the losses. The preparations containing DDT (Agrocide Cotton Dust and DDT emulsion) gave increased protection compared with lead arsenate and Toxaphene, between which there was no difference in control.

This season cotton stainers (*Dysdercus andreae*) were again of no importance. A small migration moved into cotton at Cades Bay in in the middle of the cropping season but disappeared after Agrocide dusting. Unlike last season aphis was not a factor, but observation showed some increase where DDT emulsion was used.

Acknowledgements.

The co-operation of officers of the Departments of Agriculture and of planters in carrying out the district experiments is gratefully acknowledged.

PROGRAMME FOR 1951-52.

The work will be continued along the same general lines as in the past few years. The main expansion will be in cotton selection and in trials of insecticides.

The rotation and manurial trials will be continued. As a result of the poor performance of cotton following grass in the present season $3 \times 3 \times 3$ NPK trials will be planted on land recently out of grass and sugar cane.

Insecticide trials will be continued.

Increased selection work will be carried out on the material which offers promise as possible varieties to replace MSI for commercial

planting. Variety trials will be planted as extensively as possible, and MSI and VH8 will be compared in factorial layouts under a range of conditions of soil, of land preparation and cultivation and of planting dates.

The investigation of the environmental factors affecting lint quality in MSI will be continued.

COTTON BREEDING STATION—MONTSERRAT.

Weather Conditions.

The 1950 season was unfavourable, with very low rainfall at planting time, and the dry conditions continued from March until the end of May. A good rain at the Grove Experiment Station on the last day of February made it possible to plant in the first days of March, but conditions were dry until June. In the Windward and Northern districts some 3 in. less rain fell during the period and crop establishment was difficult, resulting in much late cotton. The early crop had good weather for picking but the late crops were hampered by the storms of late August and by resultant bollrot. Pink bollworm attack was heavy, particularly in the Northern and Windward districts.

The area planted to cotton was 3,576 acres, about 250 acres less than in the previous season, and gave the very low average yield of 100 lb. clean lint per acre.

Cotton Breeding Work.

Progeny row breeding was continued. No significant differences were demonstrated in yield, but descendants of M4210 were significantly superior to those of M4213 in seed weight and lint index.

First multiplication covered 5 acres, and second multiplication 85 acres. Owing to low yields, the island seed supply had to be made up from fourth multiplication areas.

From first multiplication 150 lb. of seed were supplied to St. Kitts, 300 lb. to Nevis, and 200 lb. to Antigua. From second multiplication 300 lb. were supplied to St. Lucia and 360 lb. to Antigua. 40,000 lb. of bulk were supplied to Antigua to replace seed damaged by hurricane.

Manurial Experiments.

Nitrogen-phosphate trials were laid down on the four major soil types, using a 3×3 design with four replicates, as in previous years. Sulphate of ammonia and superphosphate were applied at two rates—200 and 400 lb. per acre—the latter being applied before planting and the former four weeks after planting.

Soil samples from the control plots were analysed by the Chemistry Department of the Imperial College of Tropical Agriculture.

Trials on Brown Earth and Shoal soils were abandoned on account of patchy germination and early growth.

Alluvial Soil.—The trial, planted at Trants on March 2nd., got established on the March rains and averaged over 700 lb. seed cotton per acre. The site had been green manured in 1947 and cropped to cotton in 1948 and 1949.

TABLE 1.

	Yields in lb. seed cotton per acre.			*Means.*
	*p*0	*p*1	*p*2	
n0	712	638	712	687·3
n1	725	813	738	758·6
n2	632	691	682	668·3
Means	689·7	714·0	710·6	704·7

The analysis revealed significant differences for the nitrogen treatments. The lower rate of sulphate of ammonia gave an increase of 10·3 per cent. (71·3 lb. per acre) over the control. At this season's prices this represents an additional $12.00 per acre after deducting the expenses of manuring. Increase from the lower level of nitrogen agrees with previous results on the soil type. The effect of phosphate was slight and not statistically significant and in general the results are in line with soil analyses.

Fresh Ash Soil.—The trial at Dagenham was a failure as a fertiliser experiment, but it gave a striking demonstration of the importance of windbreaks in a year of low rainfall. The early part of the season was dry and high winds prevailed. A belt of trees some 100 feet away sheltered part of the trial, and a comparison of the two sections of the trial gave a yield of 620 lb. seed cotton per acre from the unprotected section with 1,070 lb. (an increase of 73 per cent) on the sheltered section.

Brown Earth.—Cotton was planted on the site of the previous season's fertiliser trial where sulphate of ammonia and superphosphate at two rates (200 lb. and 400 lb. per acre) had been applied. There were no effects of phosphate either this season or in the year of application, and soil analyses have shown this soil to be adequate in P_2O_5. Response to nitrogen was obtained last year but there was no effect in the present season.

Rotation Trial.—The trial described in earlier reports was continued and the site will be planted to cotton as indicator crop in the coming season. The various treatments have an unmanured series and one receiving 5 tons of pen manure per acre. The sugar cane was damaged

by rats and is not included, but the effect of pen manure on the other crops is given below.

Table 2.

	Yields in lb. per acre.		
	Elephant Grass.	*Seed Cotton.*	*Sweet Potatoes.*
Unmanured	49,102	322	2,356
Five tons Pen Manure ...	54,864	360	3,166
% Increase	11·5%	11·7%	42%

Cultivation Trial.

A trial was carried out at the Grove to test (*a*) poor versus thorough cultivation ; (*b*) early and late land preparation ; and (*c*) the effect of nitrogenous fertilisers. A split plot layout was used with the types of cultivation occupying the whole plots. " Thorough " cultivation consisted of forking the land before ridging while " poor " cultivation simply had the weeds hoed and the land ridged. There was a period of three weeks between " early " and " late " cultivation, the latter being carried out one week before planting on March 7th. The manured series was given two applications of sulphate of ammonia, each of 125 lb. per acre, at two and seven weeks from planting.

Table 3.

Yields in lb. seed cotton per acre.			
	Early.	*Late.*	*Mean.*
Poor Cultivation	1,175·5	867·5	1,021·5
Thorough Cultivation	1,099·5	1,007·5	1,053·5
Mean	1,137·5	937·5	—

Improved plant growth in the early cultivation treatment was soon apparent and its yield increase (21 per cent.) was highly significant. This corroborates results obtained in the rotation trial last year. There was no effect of manuring or type of cultivation but a significant interaction was found between time and type of cultivation ; the bad effect of late preparation being enhanced by poor cultivation.

Grass Fallow.—The effect of delayed digging-under of grass residues was strikingly demonstrated in an observational trial at the Grove station where Guatemala, Guinea and elephant grass had been dug out. There are two replicates of three times of digging-under (*a*) early January ; (*b*) early February and (*c*) early March, just before planting to cotton. Each plot extended across the three strips of the various grasses. Differences were early apparent, the January and February treatments being far better grown than that of early March. The bad effect of planting cotton immediately after the ploughing-under of grassland is shown by the yields.

Treatment.	Yields lb. seed cotton per acre.
January Preparation	1,244
February ,, ...	1,371
March ,, ...	458

PROGRAMME FOR 1951.

1. The breeding and seed multiplication of MSI will be continued.
2. Further variety trials of Sea Island cotton strains.
3. NP trials will be continued. Potash will be included on the Brown Earth soils, where soil analyses have indicated a low level.
4. Trial of phosphate placement on Shoal soil.
5. The rotation trial will be planted to cotton as indicator crop.
6. Insecticide trials will be started.

CAMDEN PARK EXPERIMENT STATION, ST. VINCENT.

Weather Conditions.

Although rainfall from mid-August to mid-September was adequate, germination was set back by abrupt spells of excessively hot days. This resulted in the scorching of germinating seedlings and caused the supply rate to be unusually high. Later in the season, however, weather conditions improved.

Rainfall for the crop period August, 1950 to March, 1951 is shown below.

	Aug.	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Total.*
Inches ...	7·33	5·42	12·05	16·93	5·57	5·62	6·13	0·76	59·81

Pests and Diseases.

There was an unusually high and early incidence of pink bollworm in early December. The attack, however, was confined to a small area and was not a big factor in crop loss.

Cotton stainers attacked in small numbers, but were quickly controlled by the use of Toxaphene and Agrocide dusts.

The leafworm, *Alabama argillacea*, severely attacked a restricted area in January but was controlled by spraying with colloidal lead arsenate.

Small patches affected by wilt occurred on the station and in other cotton fields in the country, being noted mainly on the coastal valley soils. The affected areas were examined by Mr. Holliday of

the Imperial College of Tropical Agriculture and the causal organism identified as *Fusarium vasinfectum*. Though small in total amount the disease was fairly widely distributed. A survey of the incidence of the disease is proposed for next season, and also investigations on the effect of fertilisers and the comparative resistance of Sea Island varieties.

Breeding Programme.

V135 seed renewal scheme.—20 progenies were grown from eight progenies of the previous year. The remaining seed from the 1949–50 progenies was grown as a multiplication bulk, and gave 450 lb. of seed for 2nd multiplication next year.

VH8 hybrid material.—24 progenies with one V135 control were grown in a (5 × 5) lattice square. Yield differences were not significant. Yield differences in a small bulks trial of VH8 strains and V135 were also insignificant. Spinning test data on this material showed that the VH8 stocks compared favourably with V135 in yarn strength.

Table 1.

Yield and Yarn strength data for VH8 and V135.

	Yield (lb. lint per acre).	*Count × Strength.*
Mean of all VH8 progenies	186	2,962
V135 control	160	2,980
Mean of VH8 small bulks	116	2,833
V135 control	116	2,824

Manurial Trials.

The district NPK manurial trials started during the previous year were repeated. The layouts and treatments were similar viz :— 3 × 3 × 3 factorial design with a single replicate at each site and with sulphate of ammonia and superphosphate applied at 400 and 800 lb. per acre and sulphate of potash at 200 and 400 lb.

The trials were laid down with plots of 1/100 acre planted with V135 at 2 ft. × 3 ft. spacing. Planting dates ranged from 15th to 31st August and manures were applied four weeks later.

Main responses to fertilisers obtained on the various soil types are shown in Table 2.

Table 2.

Lb. Seed Cotton per Acre.

Sites.	*Soil Types.*	*Nitrogen.*			*Phosphate.*			*Potash.*			*Linear Sig.*	
		0	1	2	0	1	2	0	1	2	*S.E.*	*C.D.*
Richmond	Recent Volcanic (Ash)	789	1,233	1,211	1,078	1,044	1,111	1,156	1,167	911	± 96·5	205
Wallilabou	Yellow Earth (High Level)	1,978	2,389	2,322	2,255	2,200	2,233	2,211	2,244	2,233	±109·8	233
Cane Hall	Yellow Earth (Low Level)	1,522	2,089	2,000	1,756	1,822	2,033	1,855	1,966	1,788	±138·6	295
Diamond	Coastal Valley	995	1,578	1,511	1,281	1,432	1,370	1,272	1,376	1,436	±105·3	224
Pembroke	Alluvium	489	833	922	733	756	756	744	889	611	± 90·8	193

Significant responses to nitrogen were obtained on all soil types. As in last season's trials, the main response comes from the N_1 application and there is no indication of the need for a higher application. There were no insignificant responses to phosphate or potash and no indication of any interactions.

The need for application of nitrogenous manures has been shown consistently and generally in trials and their use is extending in the commercial crop.

A variety × manurial trial was laid down on volcanic ash soil, but stands were poor, and though VH8 outyielded V135 little reliance could be placed on the results.

PROGRAMME FOR 1951-52.

Breeding.—(1) V135 maintenance and multiplication.

(2) VH8 breeding and testing.

Field Experiments.—(1) District NPK manurial trials to assess residual effects.

(2) VH8 versus V135 district manurial trials.

(3) Cotton wilt (*Fusarium vasinfectum*). Investigations on (*a*) the incidence of the wilt, (*b*) the effect of fertilisers and (*c*) the comparative resistance of a number of Sea Island varieties.

Received December, 1951.

QUEENSLAND.

REGIONAL EXPERIMENTAL STATION, BILOELA.

PROGRESS REPORT FOR THE SEASON 1950-51.

BY

R. W. PETERS.

This summary has been prepared from the reports submitted by J. G. J. Stevens, R. W. George and J. Harbison of the staff of the Biloela Regional Experiment Station.

Climatic Data.

The total rainfall received during the period July–June was 24·33 inches, compared with the 27-year mean of 27·91 inches. This total was received on 84 wet days compared with a mean of 75 for previous years—the mean fall of rain per wet day being well below the average. The distribution of the rainfall from July to February was very satisfactory, with splendid rains occurring in October and November. The January rainfall was excellent and replenished the supply of soil moisture used during the dry December. Fine weather prevailing from mid-February until the end of March hastened the maturation of the cotton crops.

The maximum temperatures during most of the July–January period were below average and the minima were above average, but both classes approximated to normal for the rest of the season. No extreme heat waves were experienced during the season, the highest daily mean temperature for any week being 91·9° during December.

Table 1

Month.	*Rainfall Means.*		*Screen Maximum.*		*Screen Minimum.*	
	1950—51 *ins.*	1925—51 *ins.*	1950—51	1925—51 (*Means*)	1950—51	1925—51 (*Means*)
			°*F.*	°*F.*	°*F.*	°*F.*
July	2·82	1·33	71·7	70·8	52·5	40·2
August	1·32	0·60	71·1	74·8	41·3	40·6
September	1·09	0·96	79·0	80·2	47·5	46·3
October	3·00	1·94	81·6	85·2	56·0	54·7
November	4·85	2·94	84·9	88·5	60·4	60·4
December	1·19	3·31	88·5	90·4	63·3	64·3
January	6·43	4·23	85·3	91·8	66·0	66·8
February	2·71	4·94	88·4	89·1	63·4	66·2
March	0·48	2·70	88·4	87·7	62·6	62·8
April	0·16	1·67	86·1	82·8	51·5	54·2
May	—	1·57	78·5	77·1	42·2	47·0
June	0·28	1·72	72·8	69·6	37·2	40·9
Year	24·33	27·91	81·4	82·5	54·1	53·9

May and June experienced slightly more frosts than normally, but owing to the early cotton harvest they were too late in the season to affect to any extent the early matured cotton crop. The relative humidity for the first half of the season, except December,

was well above average, as a result of the wet cloudy weather experienced during most of this period. During late summer and the autumn the humidity was rather low owing to the extremely dry conditions.

The average monthly rainfall and temperature readings are shown in Table 1.

Soil Investigations.

Moisture Studies.—Above average rainfall was received for each month from February till November, 1950, and following approximately two inches of rain in mid-October the areas for most summer growing crops contained moisture at field capacity to approximately 36 inches. The November rainfall increased slightly the depth of wet soil already present in the cotton plots. December was fairly dry, but in most cases sufficient moisture reserves were present to enable the cotton crops to make good growth till the advent of further rain on 9th January. A total of 7·87 inches of rain was received from 9th January to 2nd February, which was sufficient to meet the demands of the rapidly growing plants and to replenish the soil moisture lost during December and early January.

Practically no further useful rain fell during the cotton season. However, the moisture present in the soil, wet to a depth of 36 inches in early February, appeared sufficient to mature all but the late ripening cotton. By the end of May the moisture content had been reduced to wilting point in the top 36 inches of soil.

Nitrate Studies.—Owing to staff shortages it was not possible to make more than a limited number of nitrate-nitrogen determinations during the season. Generally speaking, however, the wet and rather mild winter and early spring of 1950 retarded nitrate development and also caused a much higher than average utilization of nitrate by pastures during this period. This fact appeared to have an important bearing on the growth of all single species pastures during the summer, and was possibly responsible for the rapid deterioration of both the yield and quality of pasturage in the district from February onwards.

With regard to the cotton plantings, although the nitrate-nitrogen content of the soils was much below normal during the spring and early summer, there was no actual nitrogen deficiency. In fact, general growth of cotton plants was satisfactory except where the nitrate content of the soil appeared to be higher than the average for the season, when the plants tended to make rather vegetative growth.

The results confirm the findings of previous investigations, namely that, in a season experiencing very wet conditions in late winter and spring and during the early stages of growth of the cotton plant, the resultant nitrate-nitrogen status of the soil in old cultivations is suitable for production of satisfactory yields of cotton. Where cotton is grown in such seasons in the first, second or third year after

several years of Rhodes grass an even better balance of nitrate-nitrogen and moisture is usually obtained, and this, if ample moisture is available during the period of development and maturation of the bulk of the crop, results in very good yields.

In contrast to cotton, however, such seasonal conditions reduce both the yield and the crude protein content of grasses cut at hay stages compared with the results obtained in seasons experiencing dry winters and light to moderate rainfall in the spring and early summer.

Crop Growth.

The cotton was planted in October and the weather conditions were excellent for cotton growth from planting until the end of February.

Weed growth during the early part of the season was prolific but the temporary dry-up in December enabled adequate weed control to be established.

Although the supply of available nitrate-nitrogen appeared somewhat lower than usual throughout the season, rather vegetative types of plants were produced in some of the older cultivations. Dry weather in December encouraged root development and also appeared to favour early production of fruit. In most plots, however, the plants experienced only slight stress conditions prior to the onset of good rains on 9th January. The rainfall of this group was of the scattered slow type, but was sufficient to re-wet the soil to an average depth of 30–36 inches. The latter part of January was cloudy and temperatures were below normal with the result that considerable shedding of large squares and small bolls occurred.

The rate of flowering during January was remarkably even and up to the end of that month most plots had produced an average of 1,700 to 2,000 flowers per 100 foot row, this being equivalent to 17–20 flowers per plant on a 12-inch plant spacing. Because of the January square losses, however, flowering was low during early February; it increased by mid-February, and from then till mid-March the average flowering rates were approximately half those of January. There appeared to be a negative correlation between flowering rates in February and March and the yield of cotton produced. It would seem that late development and maturation of the bolls was best in plots which produced only limited numbers of flowers during February and March, whereas maturation of the bolls was rather poor in plots where the February flowering rate was relatively high. These results indicated that conditions favourable for the production of new squares tended to inhibit the maturation of bolls.

In all dry farmed plots early maturing varieties outyielded later maturing varieties. This was no doubt largely influenced by the excellent weather conditions which prevailed during most of the growth of the early varieties and the very dry weather experienced while the later varieties were nearing maturing. Empire, a recently

introduced variety, was outstanding this season. Its plant structure, yield, lint percentage, staple length and grade of fibre, picking qualities and early maturity were all of high standard. Stoneville 2B again showed its superiority under conditions of supplementary irrigation.

Table 2 briefly summarises the results from all cotton trials on the Experiment Station for 1950/51.

Table 2.

Crop	*Planting Dates.*	*Picking Dates.*	*Local Close Season.*	*Rainfall 1/7/49—30/6/50 (inches)*	*Mean Temperature Oct.—Nov.*	*Mean Yield lb. seed cotton per acre.*
Raingrown Cotton ...	Oct. 13th—24th	Apl. 17th—June 28th	Nil	24·33	Max. 83·25°F.	1,277
Irrigated Cotton	Oct. 13th—24th	Apl. 4th—June 21st	Nil	24·33 + 2 ins. application 14th—16th March.	Min. 58·2°F.	1,371

Total seed cotton production for the year was 43,280 lb. The average yield of dry farmed cotton was the highest since the 1927–28 season. Overall harvesting conditions for the 1950–51 season were excellent. This was reflected in the high grades of the seed cotton harvested.

Pests.

Insect damage was not a major limiting factor at any time during the season. A fairly heavy Aphis attack occurred in November but was controlled with a Hexone and DDT combined spray, the latter being incorporated to guard against any corn ear worm attack that might have developed. At the end of January an attack of jassid occurred but, owing probably to the dry unfavourable conditions, the attack soon disappeared.

Agronomic Trials.

Time of Watering Trial.—This experiment was a modification of last year's experiment, embracing the three leading treatments and control on second year cultivation out of virgin grassland, to test the merits of these treatments under low soil nitrate-nitrogen conditions.

Heavy rain in early October made preplanting irrigations unnecessary, and the experiment was planted on 14th October in a 4×4 randomized block design, the plots being 0·14 of an acre each.

Some plots scheduled to receive November irrigation became waterlogged from the following heavy rains, and plants in those areas were badly stunted, whereas in the plots not receiving this irrigation the plants made good development.

Healthy growth developed throughout most of December but plants of three of the treatments showed slight signs of stress at the end of that month owing to declining supply of moisture. Plants in treatment B, which received a 3-inch irrigation on 21st and 22nd

December, remained in good condition and sustained flowering to a greater extent than did the other treatments, which were not irrigated that month. The good rainfall experienced before and throughout the main growing period largely counterbalanced the benefit of an early preplanting irrigation in treatment E and the irrigation on 9th and 10th November in plots C and E.

There were no significant differences between treatments in either the first or the second (final) pickings. Slight differences which occurred in the first pick were evened out in the second one. Treatment A produced the highest actual yield and treatment C the lowest, as shown in Table 3.

TABLE 3.

Treatment.	Yield Seed Cotton lb. per acre.		
	First Pick.	Second Pick.	Total.
A. 3-in. spray irrigation 2nd—4th January	1,145	333	1,478
B. 3-in. spray irrigation 21st and 22nd December ...	1,188	274	1,462
C. 3-in. spray irrigation 9th and 10th November ...	984	343	1,328
E. 3-in. preplanting irrigation 22nd September and 3-in. irrigation 9th and 10th November	1,137	317	1,454
MEANS	1,113	316	1,430

In addition to the above spray irrigations, B, C, and E treatments were given a 3-inch spray irrigation on 2nd–4th January and all treatments a 2-inch spray application on 5th–7th March.

Irrigation × *Rotation* × *Strain Trial.*—This experiment, which consisted of a 3 × 5 × 4 randomized block design, the plots being 0·1 acre each, was planted to five strains of Miller on 13th October following 2·28 inches of rain during the previous week. The showery cool weather during November did not produce rapid early growth but the plants made excellent progress during the fairly dry, warm weather in December. All plots made good growth in January, but fairly extensive shedding of squares and small bolls occurred towards the end of that month. Shedding was noticeably more marked where plants were large and leafy.

By early March approximately 600–700 pounds of seed cotton per acre had opened. Owing to the prevailing dry conditions at this stage a 2-inch spray irrigation was applied to A and C plots on 8th March, but it is doubtful whether any benefit was derived from it. At the time of the application the plants were undergoing some stress conditions but were not wilting to any extent, although flowering was decreasing. The continued dry weather during April and May hastened the maturation of the bolls and it was possible to complete picking operations by 23rd May after killing frosts had been recorded on 11th and 12th May.

Yield data for the main treatments are shown in Table 4.

TABLE 4.

	Treatment.	Yield Seed Cotton lb. per acre.		
		First Pick.	Second Pick.	Total.
A.	Irrigated cotton following irrigated cotton following 3 years irrigated Rhodes Grass	751	621	1,372
C.	Irrigated cotton following 10 years irrigated cotton	627	531	1,158
R.	Non-irrigated cotton following 1 year dry farmed cotton following 3 years non-irrigated Rhodes Grass	1,019	588	1,607
	MEAN	799	580	1,379

For the total pick the non-irrigated plots significantly outyielded at the 1 per cent. level both the irrigated plots following grass and the irrigated plots following cotton. In the strain test the later maturing MBC strains yielded significantly less cotton than did the earlier maturing Miller 41S and 43–9 strains, the jassid resistance of the former being of minor importance in a relatively jassid free season.

Irrigated Cotton Varietal Trial.—This trial, which consisted of a 6 × 4 randomized block design, each plot being 0·013 of an acre, was planted on 24th October. Plants grew rapidly during the early stage of growth but a slight period of stress experienced in early January necessitated a 3-inch spray irrigation. This was applied on 4th January and was followed by heavy rain on 9th January.

Flowering commenced in mid-December and by the end of that month was at a satisfactory rate. All varieties reacted adversely to the below normal temperatures and the lack of sunshine during the latter half of January and lost a considerable number of squares and many newly-formed bolls. Under the drier conditions in early February, however, shedding declined and the rate of flowering improved reasonably well.

The first pick was made during the period 22nd April to 2nd May. As in last year's trial, Stoneville showed its superiority over the others, with Empire, a recently introduced variety, next best. A top crop of small bolls in this trial failed to open after frosts in May. Therefore the yields are confined to the first pick, details of which are shown in Table 5.

TABLE 5.

Variety.	Yield seed cotton lb. per acre.	Significantly Exceeds	
		1%	5%
Stoneville	1,415	2—6	2—6
Empire	1,104	6	6
D. & Pl.14	1,089	6	6
Miller 43.9.0	924	6	6
Miller 41S	919	—	6
Acala 5675	705	—	—
MEAN	1,026	—	—

Minimum difference for significance 197 lb. per acre 5%.
273 lb. per acre 1%.

Dryland Cotton Varietal Trial.

This trial was planted on land in the first year following four years of Rhodes grass which had been grown on an old cotton cultivation. The varieties were the same as those in the irrigated varietal trial, the design being a 6 × 6 randomized block experiment with plots 0·016 acre.

Satisfactory plant development was maintained, with the exception of a short period of slight stress experienced early in January, until the effects of the prolonged dry conditions, operating from February onwards, first slowed down and then terminated growth. The combination of a good supply of moisture during the main growing period and the low nitrate-nitrogen content of the soil in the first year after grassland, resulted in the development of a very satisfactory type of well-laden plant in all varieties. Yields were higher than in the irrigation trial with the exception of Stoneville 2B. This variety requires very favourable moisture conditions and its marked superiority over the other varieties in the irrigation trial compared with being second to last in the dryland experiment supports the hypothesis that the combination of the early January irrigation followed by heavy rainfall in late January provided too great a growth stimulus for most of the varieties in the irrigation trial. The resultant plant growth under such conditions tended to delay both the development and the maturation of the top crop, whereas in the dryland trial a good top crop was matured satisfactorily.

Empire, D & Pl. and Stoneville developed open types of plant structure suitable for machine harvesting, with the former having the largest bolls of all varieties and also being outstandingly the earliest maturer. The yields of the experiment are presented in Table 6.

Table 6.

Variety.		*Yield Seed Cotton lb. per acre.*		
		First Pick.	*Second Pick.*	*Total Yield.*
Empire		1,434	252	1,686
Miller 43.9.0		975	572	1,547
D. & Pl.14		963	459	1,422
Miller 41S		875	527	1,402
Stoneville 2B		922	430	1,352
Acala		865	418	1,283
Means		1,006	443	1,448
Minimum differences for significance	5%	233	95	264
	1%	319	130	—

Mechanical Harvesting.

The McCormick Deering mechanical cotton picker harvested 21·6 acres of cotton on the Station for the first pick and 23·8 acres for the second. In the first pick an average of 92·5 per cent. of the crop was obtained as compared with handpicked rows. The efficiency of the second pick was somewhat lower owing chiefly to reduced yields. The first pick graded SLM as compared with SM for handpicked plots. On the second pick the machine grades were again SLM while the

handpicked graded Middling. The differences in the grades were due mostly to greater leaf in the machine-picked material. The machine harvested satisfactorily a total of 25,185 lb. of seed cotton on the Station.

Two trials were planted, one under irrigation and one under dry farming conditions, using 13 and 10 varieties respectively, to examine suitability of varieties for mechanical harvesting.

In the irrigated trial, total yields varied from 1,834 to 854 pounds of seed cotton per acre, with a mean of 1,463, and in the dry land trial, total yields varied from 1,970 to 1,226, the mean being 1,705.

The efficiency of the mechanical harvester varied from 86·7 per cent. in Rowden to 98·1 per cent. in Empire. In testing the efficiency of the mechanical harvester in the second pick all cotton remaining after mechanical harvesting was removed by hand from three short measured lengths of row in each plot. This cotton was weighed and converted into a pounds of seed cotton per acre basis for adding to the weight of machine harvested cotton to give the total yield of the variety concerned and the percentage of this weight harvested by the machine. The residual amount of cotton was in some cases rather high, but in general the good yields favoured efficient picking by the harvester.

The results indicated that several of the commercial varieties can be mechanically harvested fairly satisfactorily. Under the conditions of this season, however, the machine tended to leave approximately the same amount of cotton on the plants irrespective of yield and as it harvested at an average rate of 1,000 lb. seed cotton per hour in bulk plantings, its operation was more efficient and economical in the high yielding cotton crops.

Cotton Breeding.

Work continued in the jassid resistant backcross Miller strains. Multiplication of last year's most promising progeny increases yielded sufficient seed to allow of isolated commercial plantings on jassid susceptible areas and testing with standard Miller varieties during the coming season.

Further plant selection work was carried out in the main progeny plot of these strains, which yielded at the rate of 1,961 lb. of seed cotton per acre, equivalent to approximately 725 lb. of lint. A number of progeny increases were retained for multiplication and testing and many new individual plant selections were taken for laboratory examination.

Entomological Investigations.

Trials to examine the merits of various sprays for the control of *Heliothis armigera* Hbn. were carried out in irrigated and non-irrigated cotton.

The irrigated trial consisted of a 4 × 10 randomized block experiment on land that had grown irrigated cotton since 1945, the plot size being 0·05 acre. It was planted on the 13th October with ample moisture available. Early growth was rapid and continued throughout November and December. Egg counts made on 18th December disclosed an average of nine eggs per 100 terminals and it was decided to apply the insecticidal treatments on 19th December. *Heliothis* activity during January was only light, but as a precaution the treatments were repeated on 30th January. Both eggs and damaged square counts rose more rapidly during early February and spraying was again resorted to on 15th February. Counts made on 21st February indicated that all treated plots had fewer eggs and damaged squares than the controls, but these differences were not reflected in the flower counts for late February and March. However, the flower counts for early and mid-January did appear to reflect some benefit from the December spraying.

Yield data are shown in Table 7.

TABLE 7.

Treatment.	Yields Seed Cotton lb. per acre.		
	First Pick.	*Second Pick.*	*Total Yield.*
A. Control	612	554	1,166
B. 0·4% DDT when egg and square counts indicated *Heliothis* activity...	709	597	1,305
C. 0·015% Folidol (Parathion) applied as for B treatment	663	572	1,235
D. 0·2% DDT plus 0·0075 Folidol as per B treatment ...	655	598	1,253
MEANS	660	580	1,240

There were no significant differences.

The non-irrigated entomological experiment was designed as a simple Student's comparison, with twelve plots each of control and 0·4 per cent. DDT spray when egg counts indicated *Heliothis* activity. Planting took place on 13th October on newly ploughed-up Rhodes grass land. Early in the summer, nitrate deficiency was evident as a result of late ploughing-in of the grass and inadequate decomposition of the organic matter.

Two sprayings were given, the first on 19th December at 20 gallons per acre. The second, on 30th January at 40 gallons per acre, was followed by heavy rain. As both egg and damaged square counts rose during early February as in the irrigated trial, 2 per cent. DDT dust was applied at the rate of 24 lb. per acre. This dusting appeared to control the *Heliothis* activity fairly well and in late February it was found that the DDT plots contained only six eggs per 100 terminals as compared with 28 in the control plots, and 12 per cent. damaged squares as compared with 20 per cent. in the control plots. Each terminal was examined on 20 samples of five consecutive plants in each acre. Spacing was 3½ feet between rows by 1 foot between plants.

The yields are given in Table 8.

TABLE 8.

	Yield Seed Cotton lb. per acre.		
	First Pick.	*Second Pick.*	*Total.*
DDT Plots	602	628	1,230
Control Plots	531	575	1,106
Means	566	602	1,168
Differences	Sign.	Sign.	Highly Sign.

PROGRAMME FOR 1951-52.

Plant Breeding.—Multiplication of the most promising strains of jassid-resistant hybrids, examination of the newer progenies and selections and comparison of the more advanced strains with standard varieties under irrigation conditions.

Agronomic Experiments.—Continuation of the general programme carried out in the 1950–51 season.

Mechanical Harvesting.—In view of the interest and importance attached to mechanical harvesting of cotton in Queensland varietal experiments for machine harvesting will be continued.

Entomological Experiments.—Repetition of the 1950–51 investigations into the merits of various sprays for the control of *Heliothis armigera* Hbn. in irrigated and non-irrigated cotton.

Received October, 1951

EMPIRE COTTON GROWING CORPORATION

12, Chantrey House, Eccleston Street, S.W.1.

List of Publications issued to date. Those still in print can be obtained direct from the Corporation at the above address. Those out of print are marked with an asterisk. The prices include postage.

GENERAL AND TERRITORIAL.

"Cotton Growing within the British Empire and the World's Capacity for Consuming Cotton Goods." J. W. McConnel. 1921. Price **2s.**

* "Cotton Growing in Nigeria." Sir Hector Duff. 1921.

"The Extension of Cotton Cultivation in Tanganyika Territory." Major Hastings Horne. 1922. Price **2s.**

* "Cotton Cultivation in Nyasaland." H. C. Sampson. 1922.

* "Cotton Growing within the British Empire." L. G. Killby. 1924.

"Cotton Growing in South Africa." G. F. Keatinge. 1925. Price **2s.**

"A Cotton Research Station for the British Empire." Professor J. B. Farmer and Mr. L. G. Killby. 1925. Price **2s.**

"Report on the Cotton-Growing Industry in Uganda, Kenya, and the Mwanza District of Tanganyika." Col. C. N. French. 1925. Price **1s. 3d.**

"Memorandum by the Mechanical Transport Sub-Committee." Mr. G. H. Baillie, Mr. R. H. Brackenbury, Col. C. N. French, 1925. Price **2s.**

"Report on the Cotton-Growing Industry of Nigeria 1926." Col. C. N. French. 1926. Price **2s.**

* "The Principles and Practice of Yield Trials." F. L. Engledow and G. Udny Yule. 1926.

"Report on Suitable Rotation Crops for Cotton." H. C. Sampson. 1927. Price **1s.**

"Cotton Growing in Southern Africa and the Rhodesias." Report on a Tour undertaken by Sir James Currie, Mr. J. S. Addison, and Mr. H. C. Jefferys. 1927. Price **2s.**

* "Reports from Turkestan Plant Breeding Station, Tashkent." 1928.

"Review of the Situation in the Principal Cotton-Growing Territories of the Empire, and a Summary of the Main Activities of the Corporation since their Formation." 1928. Price **9d.**

"Report on Cotton Breeding and Seed Supply in Nigeria, 1928." F. L. Engledow and C. N. French. Price **2s.**

* "Conference of Workers on Cotton-Growing Problems, held August, 1930." Papers and Discussions.

"Conference of Workers on Cotton Growing Problems, held July, 1934." Papers and Discussions. Price **2s. 6d.**

* "The Principles and Practice of Field Experimentation." J. Wishart and H. G. Sanders. 1935.

* Out of print.

"Cotton Pest Control Work in Southern and Central Africa and the Rhodesias." J. W. Munro. 1937. Price **2s. 6d.**

"Conference of Workers on Cotton Growing Problems, held September, 1938." Report of Proceedings and Papers Submitted. Price **2s. 6d.**

"Spinning Test Methods—Shirley Institute, 1948." C. Underwood. 1949. Price **1s.**

"Field Key to the Principal Disorders of Cotton in Africa." E. O. Pearson. 1950. Price **6d.**

"Short History of the Empire Cotton Growing Corporation, 1921 to 1950." 1951. Free.

PROGRESS REPORTS FROM EXPERIMENT STATIONS.

Seasons still in print : 1923–25 (one volume price **2s.**) ; 1926–27, 1931–32, 1934–35, 1935–36 (price **2s. 6d.** each) ; 1942–43, 1945–46 and subsequent seasons (price **3s.** each).

REVIEW OF THE WORK OF THE EXPERIMENT STATIONS.

Seasons 1933–34, 1934–35, J. C. Willis ; 1935–36, 1936–37, W. Nowell ; 1937–38, 1938–39, W. Nowell and J. W. Munro. Price **1s. 6d.** each. From 1939 published triennially in one volume :—1939–40 to 1941–42, 1942–43 to 1944–45, W. Nowell. Price **2s.** each.

MEMOIRS OF THE COTTON RESEARCH STATION, TRINIDAD.

Price **2s. 6d.** each.

Series A : Genetics.

* **No. 1.** The Inheritance of (i) Petal Spot, (ii) Pollen Colour, (iii) Corolla Colour. S. C. Harland. 1929.

* **No. 2.** Studies on the Inheritance of Corolla Colour and Petal Size in Asiatic Cottons. J. B. Hutchinson. 1931.

* **No. 3.** (*a*) Reversal of Dominance in the Interspecific Cross *G. barbadense* Linn. × *G. hirsutum* Linn. and its Bearing on Fisher's Theory of Dominance. (*b*) The Inheritance of Chlorophyll Deficiency in New World Cottons. S. C. Harland. (*c*) "Crumpled." A New Dominant in Asiatic Cottons produced by Complementary Factors. J. B. Hutchinson. 1932.

* **No. 4.** The Inheritance of Anthocyanin Pigmentation in Asiatic Cottons. J. B. Hutchinson. 1933.

* **No. 5.** The Mitosis and Meiosis in Diploid and Triploid Asiatic Cotton. A. Skovsted. 1933.

* **No. 6.** (*a*) Further Experiments on the Inheritance of the Crinkled Dwarf Mutant of *G. barbadense*. S. C. Harland. (*b*) Two Interspecific Hybrids between Asiatic and New World Cottons. A. Skovsted. 1934.

No. 7. The Inheritance of Leaf Shape in Asiatic *Gossypiums*. J. B. Hutchinson. 1934.

No. 8. Further Experiments on the Inheritance of Chlorophyll Deficiency in New World Cottons. S. C. Harland. 1934.

No. 9. (*a*) Some New Interspecific Hybrids in the Genus *Gossypium* L. (*b*) A Hybrid between *G. Davidsonii* and *G. Sturtii*. A. Skovsted. 1935.

* **No. 10.** (*a*) Homologous Genes for Anthocyanin Pigmentation in New and Old World Cottons. (*b*) A Third Series of Experiments with the Crinkled Dwarf Mutant *G. barbadense* L.—The Cross *barbadense* crinkled × *hirsutum* crinkled. (*c*) The Inheritance of Brown Lint in New World Cottons. S. C. Harland. 1935.

* Out of print.

* **No. 11.** Chromosome Numbers in the Malvaceæ I. A. Skovsted. 1935.

No. 12. The Inheritance of Fuzz and Lintlessness and Associated Characters in Asiatic Cottons. J. B. Hutchinson. 1935.

No. 13. Some Observations in the Inheritance of Form and Size in Asiatic Cottons. J. B. Hutchinson. 1936.

* **No. 14.** Chromosome Conjugation in Interspecific Hybrids. A. Skovsted. 1937.

No. 15. (*a*) The Genetics of Leaf Shape in Diploid Cottons and the Theory of Gene Interaction. (*b*) The Genetics and Taxonomic Distribution of some specific Lint Quality Genes in Asiatic Cottons. R. A. Silow. 1939.

* **No. 16.** (*a*) The Genetic Interpretation of Plant Breeding Problems. J. B. Hutchinson. (*b*) Inheritance of Quantitative Characters and Plant Breeding. V. G. Panse. 1940.

No. 17. The Comparative Genetics of *Gossypium anomalum* and the Cultivated Asiatic Cottons. R. A. Silow. 1941.

* **No. 18.** Anthocyanin Pattern in Asiatic Cottons. R. A. Silow and C. P. Yu. 1942.

* **No. 19.** Colchicine-Produced Polyploids in *Gossypium*. (i). An Autotetraploid Asiatic Cotton and certain of its Hybrids with Wild Diploid Species. S. G. Stephens. 1943.

* **No. 20.** The Efficiency of Progeny Row Breeding in Cotton Improvement. J. B. Hutchinson and H. L. Manning. 1943.

* **No. 21.** The Inheritance of Lint Colour in Asiatic Cottons. R. A. Silow. 1944.

* **No. 22.** The Genetic Organization of Leaf-Shape Development in the genus *Gossypium*. S. G. Stephens. 1944.

* **No. 23.** The Genetics of Species Development in the Old World Cottons. R. A. Silow. 1944.

* **No. 24.** I. Colchicine-Produced Polyploids in *Gossypium*. (ii) Old World Triploid Hybrids. II. A Genetic Survey of the Leaf Shape in New World Cottons—a Problem in Critical Identification of Alleles. III. The modifier concept. A Developmental analysis of Leaf-Shape " modification " in New World Cottons. IV. Canalization of Gene Action in the *Gossypium* Leaf-Shape System and its bearing on certain Evolutionary Mechanisms. S. G. Stephens. 1945.

* **No. 25.** The Sea Island Cottons. J. B. Hutchinson and H. L. Manning. 1945.

* **No. 26.** I. The Genetics of " Corky " ; (i) The New World Alleles and their possible rôle as an interspecific isolating mechanism. S. G. Stephens. II. The Crinkled Dwarf Allelomorph Series in the New World Cottons. J. B. Hutchinson. III. Evidence on Chromosome Homology and Gene Homology in the Amphidiploid New World Cottons. R. A. Silow. 1946.

* **No. 27.** I. The Seed Hairs of *Gossypium* Species. J. B. Hutchinson, S. G. Stephens, and K. S. Dodds. II. The Inheritance of Brown Lint in New World Cottons. J. B. Hutchinson. III. On the Occurrence and Significance of Deleterious Genes in Cotton. J. B. Hutchinson. 1946.

Series B : Physiology.

* **No. 1.** Studies on the Transport of Carbohydrates in the Cotton Plant. Parts I and II. T. G. Mason and E. J. Maskell. 1928.

* **No. 2.** Studies on the Transport of Nitrogenous Substances in the Cotton Plant. Parts I., II. and III. E. J. Maskell and T. G. Mason. 1930.

* Out of print.

No. 3. Studies on the Transport of Nitrogenous Substances in the Cotton Plant. IV. The Interpretation of the Effects of Ringing, with special reference to the Lability of the Nitrogen Compounds of the Bark. V. Movement to the Boll. E. J. Maskell and T. G. Mason. 1930.

No. 4. Studies on the Transport of Carbohydrates in the Cotton Plant. III. The Polar Distribution of Sugar in the Foliage Leaf. E. Phillis and T. G. Mason. 1933.

* **No. 5.** Further Studies on Transport in the Cotton Plant. I. Preliminary Observations on the Transport of Phosphorus, Potassium and Calcium. II. An Ontogenetic Study of Concentrations and Vertical Gradients. T. G. Mason and E. J. Maskell. 1934.

No. 6. Studies on the Transport of Nitrogenous Substances in the Cotton Plant. VI. Concerning Storage in the Bark. T. G. Mason and E. Phillis. 1934.

* **No. 7.** Further Studies on Transport in the Cotton Plant. III. Concerning the Independence of Solute Movement in the Phloem. T. G. Mason, E. J. Maskell and E. Phillis. IV. On the Simultaneous Movement of Solutes in Opposite Directions through the Phloem. E. Phillis and T. G. Mason. 1936.

No. 8. Further Studies on Transport in the Cotton Plant. V. Oxygen Supply and the Activation of Diffusion. T. G. Mason and E. Phillis. Concentration of Solutes in Sap and Tissue, and the Estimation of Bound Water. T. G. Mason and E. Phillis. 1936.

No. 9. Further Studies on Transport in the Cotton Plant. VI. Interchange between the Tissues of the Corolla. E. Phillis and T. G. Mason. 1936.

No. 10. The Effect of Light and of Oxygen on the Uptake of Sugar by the Foliage Leaf. E. Phillis and T. G. Mason. 1937.

No. 11. Experiments on the Extraction of Sap from the Vacuole of the Leaf of the Cotton Plant, and their bearing on the Osmotic Theory of Water Absorption by the Cell. T. G. Mason and E. Phillis. Studies on the Partition of the Mineral Elements in the Cotton Plant. (i) Preliminary Observations on Nitrogen and Phosphorus. E. Phillis and T. G. Mason. 1939.

No. 12. Further Studies on Transport in the Cotton Plant. VII. Simultaneous Changes in the Production and Distribution of Dry Matter under Varying Potassium Supply. E. Phillis and T. G. Mason. 1939.

No. 13. (*a*) The Effect of Ringing in the Upward Movement of Solutes from the Root. (*b*) The Effect of Ringing and of Transpiration on Mineral Uptake. E. Phillis and T. G. Mason. 1940.

No. 14. Concerning the Upward Movement of Soil Solutes. T. G. Mason and E. Phillis. Studies on the Partition of the Mineral Elements in the Cotton Plant. (ii) Preliminary Observations on Potassium, Calcium and Magnesium. E. Phillis and T. G. Mason. On the Expression of Sap by Low Pressure. E. Phillis and T. G. Mason. 1941.

No. 15. I. On Diurnal Variations in the Mineral Content of the Leaf of the Cotton Plant. E. Phillis and T. G. Mason. II. Studies on Foliar Hydration in the Cotton Plant. (i) The Effects of Potassium Supply and Size of Plant. (ii) Preliminary Observations using the Disc Culture Method. T. G. Mason and E. Phillis. III. Studies on the Partition of the Mineral Elements in the Cotton Plant. (iii) Mainly concerning Nitrogen. E. Phillis and T. G. Mason. 1943.

* Out of print.

No. 16. I. Studies on Foliar Hydration in the Cotton Plant. (iii) Preliminary Observations using the Pruning Method. E. Phillis and T. G. Mason. (iv) The Influence of Composition and Concentration of Nutrient Solution. T. G. Mason and E. Phillis. (v) A Further Experiment with Potassium. E. Phillis and T. G. Mason. II. Studies on the Partition of the Mineral Elements in the Cotton Plant. (iv) More about Nitrogen, Phosphorus, and Labile Carbohydrate. T. G. Mason and E. Phillis. 1944.

No. 17. I. Studies on Foliar Hydration in the Cotton Plant—(vi) A Gel Theory of Cell Water Relations. E. Phillis and T. G. Mason. II. The Effect of Ringing and of Transpiration on Mineral Uptake. A Reply to Criticism. T. G. Mason and E. Phillis. III. Studies on the Partition of the Mineral Elements in the Cotton Plant. (v) An Adsorption Theory of Nitrogen Regulation. T. G. Mason and E. Phillis. IV. The Effect of Extreme Desiccation on the Viability of Cotton Seed. E. Phillis and T. G. Mason. 1946.

No. 18. Studies on Foliar Hydration in the Cotton Plant. (vii) The Size Factor. T. G. Mason. 1947.

EMPIRE COTTON GROWING CORPORATION
RESEARCH MEMOIRS.

Price **2s. 6d.** each.

No. 1. Breeding Cotton Resistant to Blackarm Disease. R. L. Knight. 1946.

No. 2. Notes on the Classification and Distribution of Genera related to *Gossypium*. J. B. Hutchinson. 1947.

No. 3. The Role of Major Genes in the Evolution of Economic Characters. R. L. Knight. 1948.

No. 4. The Development of Internal Boll Disease of Cotton in Relation to Time of Infection. E. O. Pearson. 1948.

No. 5. Observations on the Development of the Cotton Boll, with Particular Reference to Changes in Susceptibility to Pests and Diseases. R. C. Rainey. 1948.

No. 6. Experimental Methods with Cotton.—Sulphuric Acid Treatment of Cotton Seeds. Effects of Gap-filling on Development and Yield. D. MacDonald, W. L. Fielding and D. F. Ruston. Ginning Percentage and its Determination in Variety Trials. Determination of Staple Length in Single Plant Selections and Variety Trials. W. L. Fielding. 1948.

No. 7. Jassid Resistance and Hairiness of the Cotton Plant. F. R. Parnell, H. E. King and D. F. Ruston. 1949.

No. 8. Response of Cotton to Leaf-Curl Disease. J. B. Hutchinson, R. L. Knight and E. O. Pearson. 1950.

No. 9. Confidence Limits of Expected Monthly Rainfall. H. L. Manning. 1951.

No. 10. The Distribution of Wild Species of *Gossypium* in the Sudan. R. L. Knight. The Cytological Relationships of *Gossypium somalense* : Gürke. H. Douwes. 1951.

No. 11. The Evolution of Blackarm Resistance in Cotton. R. L. Knight and J. B. Hutchinson. 1951.

No. 12. Intra-Specific Differentiation in *Gossypium hirsutum*. J. B. Hutchinson. 1951.

EMPIRE COTTON GROWING REVIEW.

" The Empire Cotton Growing Review " is the official organ of the Empire Cotton Growing Corporation. It is published quarterly (in January, April, July and October) and contains original articles, reviews, and notes on scientific, commercial and technical literature. The price of each issue is **2s. 6d.** post free.

Printed in England by Waterlow & Sons Limited, London & Dunstable.

OVERSEAS STAFF

(at 31st March, 1952)

EAST AFRICA

COTTON RESEARCH STATION, NAMULONGE, UGANDA

Dr. J. B. Hutchinson C.M.G. F.R.S.	Director
Mr. D. MacDonald - - -	Plant Breeding
Mr. H. L. Manning - - -	,, ,,
Mr. A. N. Prentice - -	Crop Husbandry & Physiology
Mr. H. G. Farbrother - -	,, ,, ,, ,,
Mr. J. P. Evenson - - -	,, ,, ,, ,,
Mr. E. O. Pearson - - -	Entomology
Mr. Q. A. Geering - - -	,,
Dr. G. M. Wickens - - -	Plant Pathology
Mr. A. H. Fish M.B.E. - -	Secretary
Mr. A. L. Stephens M.B.E. -	Farm Manager
Mr. B. E. M. Petit - - -	Assistant Farm Manager

UKIRIGURU, LAKE PROVINCE, TANGANYIKA

Mr. J. E. Peat - - - -	Deputy Senior Officer, East Africa
Mr. J. M. Munro - - -	Plant Breeding
Mr. R. Smith - - - -	,, ,,

ILONGA, EASTERN PROVINCE, TANGANYIKA

Mr. A. G. Bebbington - -	Plant Breeding
Mr. H. J. de S. Disney - -	Entomology

KISUMU, KENYA

Mr. M. S. Hastie - - -	Plant Breeding

ANGLO-EGYPTIAN SUDAN

WAD MEDANI, GEZIRA

Mr. R. R. Anson - - -	Consultant in Cotton Breeding (Sudan and Aden)
Mr. M. F. Rose - - -	Plant Breeding
Mr. L. C. Hughes - - -	,, ,,

SHAMBAT, KHARTOUM

Dr. H. Douwes - - -	Cytogenetics
Mr. R. L. Cuany - - -	,,
Mr. J. E. W. Sadd - -	Genetics

KADUGLI, KORDOFAN

Mr. K. C. Barlow - - -	Plant Breeding

NYASALAND

DOMIRA BAY, CENTRAL PROVINCE

Mr. H. C. Ducker - - -	Plant Breeding
Mr. R. Soar - - - -	Farm Manager

NIGERIA

SAMARU, ZARIA PROVINCE

Mr. H. E. King - - -	Plant Breeding
Mr. J. H. Saunders - -	,, ,,
Mr. A. F. H. Baillie - -	Entomology

BAUCHI PROVINCE

Mr. A. M. Krzywon - -	Seed Multiplication, Cotton Marketing Board

WEST INDIES

ANTIGUA

Mr. J. V. Lochrie, O.B.E. -	Cotton Officer, West Indies